JMBFS
Journal of Microbiology, Biotechnology and Food Sciences
International peer-reviewed scientific online journal
Published by Faculty of Biotechnology and Food Sciences

FOOD PROCESSING WASTE IN VIETNAM: UTILIZATION AND PROSPECTS IN FOOD INDUSTRY FOR SUSTAINABILITY DEVELOPMENT

Ngo Van Tai[1], *Vo Quang Minh*[2], *Nguyen Minh Thuy*[3, *]

Address(es): Nguyen Minh Thuy
[1] School of Food Industry, King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand.
[2] College of Environment and Natural Resources, Can Tho University, Can Tho 90000, Vietnam.
[3] Institute of Food and Biotechnology, Can Tho University, Can Tho 90000, Vietnam.

*Corresponding author: nmthuy@ctu.edu.vn

https://doi.org/10.55251/jmbfs.9926

ARTICLE INFO

Received 25. 2. 2023
Revised 14. 5. 2023
Accepted 16. 5. 2023
Published 1. 8. 2023

Regular article

OPEN ACCESS

ABSTRACT

Vietnam is a country that produces a variety of agricultural products, including vegetables, tubers, fruits, and processed products. Along with the increase in population, the demand for consumers also increases, and the by-products of farming are increasing and being discharged into the environment. This is one of the critical research issues that need to be solved to ensure sustainability in agriculture. This review summarized recent studies on familiar sources of by-products in Vietnam, such as banana peels, citrus peels, dragon fruit skins, rice bran, and rice husks, and their potential in the food industry. Some solutions are also proposed to solve and turn this low-value raw material into a high-value product and serve a variety of products and consumers in the food industry. Especially after the COVID-19 pandemic, the by-products contain valuable and reusable biological resources. These compounds could be future applications to support improving the consumer's immune system and various health benefits. Processed and utilized by-products from food production could not only help increase incomes for farmers, especially in developing countries like Vietnam but also could aid in ensuring food security and sustainability in agricultural production.

Keywords: agricultural, sustainable, utilization, waste

INTRODUCTION

Currently, sustainability, along with food security, is one of the top concerns around the world, which is also related to the problem of environmental pollution. According to research by **Kaza et al. (2018)**, food and agricultural waste account for 44% of the entire amount of urban solid waste generated worldwide, which has been rising every year. In addition, the rapidly rising consumer demand and the growth of the global population made an agricultural waste account for a large part and constantly increase every year **(Gustavsson *et al.*, 2011)**. The waste was usually not used further and had low value. The development of the economy in modernization and urbanization and new awareness about the global environment requires appropriate treatment of this waste source because the discharge level is increasingly complex **(Cho *et al.*, 2020)**. Agricultural waste accounts for the majority and is classified into crop, livestock, and food processing waste **(Nwakaire *et al.*, 2016)**. Vietnam has a tropical climate suitable for the growing conditions of many plants such as citrus, pineapple, shallot, etc., especially in the Mekong Delta region. Many fruits and vegetables are produced and consumed in fresh and processed forms. However, along with having various products from vegetables and fruits, abundant by-products are discharged and are not also appropriately utilized. It could be seen that the waste from agriculture production accounted for 10-30% of total weight; for example, pomelo peel accounted for 30% of total fruit weight **(Zarina & Tan, 2013)**, and the skin of shallot was approximately 10% of total weight **(Thuy *et al.*, 2020)**. The majority of these by-products, such as banana peels, dragon fruit skins, jackfruit rags, jackfruit seeds, citrus fruit peels, shallot skins, etc., have significant moisture contents and are therefore particularly problematic. Agricultural by-products are mainly from the crop and livestock industries in the Southeast and Mekong Delta regions, with more than 13.9 million tons in 2020 and 39.4 million tons **(Hương, 2021)**. However, local and international studies showed that by applying proper treatment methods, these wastes might be used to generate valuable by-products **(Tai *et al.*, 2021a, 2021b)**. Contrary, if not managed properly, these wastes can produce other compounds that pollute or degrade the environment, health, and the economy. The importance of waste recycling and its economic potential is mostly unseen by agriculturists **(Nwakaire *et al.*, 2016)**. As environmental consciousness grows, there is increased interest in turning agricultural wastes into valuable products **(Szabo *et al.*, 2019)**.

Especially during the COVID-19 pandemic, consumers are increasingly interested in their health and immune-improving products **(Galanakis *et al.*, 2021)**. Some by-products, such as onion peel waste, are created with large amounts of the compound quercetin, which may help improve antioxidant function and maintain immunity **(Thủy *et al.*, 2018; Thuy *et al.*, 2020)**. Fruit and vegetable waste is the best source of compounds such as polysaccharides, proteins, natural citric, phytochemicals, dietary fiber, and flavors, known for their antioxidant, anti-inflammatory, anti-bacterial, and anti-allergic properties **(Sagar *et al.*, 2018; Socaci *et al.*, 2017)**. Based on the basic idea of a circular economy by **Bigdeloo *et al.* (2021)** showed that consumer psychology and the 6Rs principle (rethink/re-decision, reduce, reuse, recycle, recovery, residuals management) has a great impact on the utilization of agricultural waste. They can become a precious resource before being discharged into landfills. Moreover, in terms of economics, using by-products to process valuable food helps increase the income of gardeners or producers while reducing the armful burden on the environment. Even with such a significant amount of waste, there is still a lot of interest in the creation of new, cutting-edge waste recycling techniques that have attributes like quick, clean, sustainable, and affordable recycling. In view of sustainability and the circular economy's connection to waste from food, scientific researchers have been looking for affordable and environmentally acceptable processing methods and procedures. A practical approach is to assess the nutritional value of the waste by applying the necessary procedures.
The survey was conducted (n = 200) to identify the agriculture which commonly produces waste and could re-use as value added products. Two questions, "What kind of agricultural raw material after food production often produces a lot of by-products?" and "Which agricultural by-products have the potential to be reused in the food industry?", were used for investigation. The participants could give the responses from the list answers for each question or can add more information to the other answer box. Among the wide range list of agricultural materials, eight materials as rice, banana, jackfruit, passion fruit, pomelo, orange, pineapple, and dragon fruit were chosen. This review includes recent studies of common food processing wastes, identification of the components contained in them, recommendations, and effective methods and solutions for reuse, extraction, and purification into value-added products. At the same time, the applicability in the food industry is also evaluated, and the assessment of sustainability and economic efficiency is also given. Daily aggregated information can help agricultural producers, processors, and investors determine the sustainability and economics of

locally available and abundant agricultural resources. Due to the limit of industrial application of these materials, this review could also give a recommendation for upscale production in the food industry based on the potential usage.

RECENT STATUS AND RESEARCH ON COMMON FOOD PROCESSING WASTE IN VIETNAM AND THEIR POTENTIAL NUTRIENT COMPOSITIONS

Rice (*Oryza sativa*)

Rice ranks among the top ten most valued commodities in terms of Vietnam's largest export turnovers. The economic impact of the cultivation of rice, however, is negligible and unsustainable. Compared to other countries, the value of rice produced in Vietnam is still low, and production costs, notably energy costs, are high **(Cong, 2016)**. Furthermore, rice by-products, including rice husk and bran, have not been effectively recovered and utilized. Additionally, one of the biggest problems facing the rice processing industry is waste and pollution, which leads to a waste of resources, increased expenses, a decline in product quality, damage to the working environment and ecosystems, and a bad reputation for the businesses **(Cong, 2016; Loan *et al.*, 2023)**. In recent years, researchers and food companies have made efforts to develop processing processes and utilize by-products from rice production and processing and have initially shown success. Specifically, the research by **Thuy *et al.* (2021)** has taken advantage of rice bran in processing traditional fermented vegetable products. This is new research that can be developed on an industrial scale and take advantage of the abundant nutrients from rice bran in the processing of traditional products **(Thủy *et al.*, 2022)**. Lactic-fermented products are also considered one the future products because they bring many health benefits to consumers. **Jaichakan *et al.* (2019)** found that cellulolytic enzymes may produce mixed oligosaccharides from rice husk, rice straw, and defatted rice bran, which can be used for prebiotic characteristics. Glucose solution hydrolyzed by rice bran was also obtained by **Liên and Thuỷ (2016)**. Some other studies also extracted some components from rice bran, such as protein **(Ly *et al.*, 2018; Trang and Pasuwan, 2018)** and lipids **(Truong *et al.*, 2017)**. Some types of bran also contain components with functional properties, such as anthocyanins from rice bran "Cẩm"' **(Lê *et al.*, 2021)**. The recycling and utilization of waste brings about economic and social benefits and are essential in protecting the environment. Therefore, other innovative techniques should be applied to recover and reuse the potentially abundant materials, which contribute to the sustainable development of Vietnam.

Banana (*Musa* sp.)

The most popular and important tropical fruits eaten worldwide are bananas (*Musa* sp.). In addition, it is typically grown on all types of land in Vietnam, making it a significant commercial crop. Dried bananas, smoothies, ice cream, bread, flour, wine, and some functional meals are just a few examples of banana products that have undergone small- to medium-scale processing **(Hiền and Thủy, 2014; Thuy *et al.*, 2022a)**. Among a lot of varieties cultivated in Vietnam, the "Xiêm" banana was commonly used on an industrial scale and studied recently **(Thuy *et al.*, 2023a; Thuy *et al.*, 2022b; Thuy and Van Tai, 2022; Tran *et al.*, 2023)**. Studies on the functional characteristics of bananas have attracted more attention, especially their ability to reduce the starch digestibility index, helping to assist in the adjustment of the glycemic index when consuming starchy products fortified starch, or non-starch from bananas. Peel, which makes up 18-30% of the entire fruit, is the primary by-product of bananas **(Tai *et al.*, 2021a, 2021b)**. Nevertheless, a lot of banana peels are thrown away as waste into the environment in the food processing sector, which has a detrimental effect on the residential areas nearby. It is a perfect substrate for the creation of value-added products since it contains minerals, different amino acids, and antioxidant compounds, as well as considerable amounts of carbohydrates, proteins, and fiber **(Tai *et al.*, 2021b)**. Recently, Vietnamese researchers applied the conventional drying method to reuse "Xiêm" banana peel **(Tai *et al.*, 2021a)**. Besides, under extraction by ethanol, "Xiêm" banana peel extract contained a high content of phenolic and flavonoid, 62.41 mgGAE/g and 6.98 mgQE/g, respectively. Another group of Malaysian scientists summarized that many biological compounds with various functionalities were found in banana peel extract **(Mohd Zaini *et al.*, 2022)**. A few of the effects of the peel that have been studied and customarily applied for a long time include burns, anemia, diarrhea, ulcers, inflammation, diabetes, cough, snakebite, and heavy menstruation. **(Fries and Waldron, 1950; Gore and Akolekar, 2003; Kumar *et al.*, 2012; Pereira and Maraschin, 2015)**. Moreover, it has a reputation for having high concentrations of nutritional fiber and bioactive substances **(Lopes *et al.*, 2020)**. The substance also has strong antioxidant, anti-microbial, and antibiotic capabilities, which have been established **(Li *et al.*, 2019)**. It may therefore be applied in the pharmaceutical and nutraceutical businesses in the future. Comparing banana peels to other fruits, phenolics-essential secondary metabolites-are more prevalent in banana peels **(Bashmil *et al.*, 2021)**. Phenolic compounds have been related to several health advantages, including cardiovascular disease prevention, cancer prevention, diabetes prevention, and obesity prevention **(Reboredo-Rodríguez *et al.*, 2018)**. The potential inhibition of lipid oxidation as well as the growth of molds and bacteria led to the banana peel could be converted into functional food **(Vu *et al.*, 2018)**. Hence, extracting these secondary metabolites from banana peels may result in usable materials, raising the value of the banana sector. Factors impacting the quantities of phenolic compounds in the peel include the chemical composition (particularly individual phenolics) was recently investigated. To be efficiently recovered and used, these metabolites must all be studied for their potential uses as constituents in foods or therapeutic agents.

Dragon fruit (*Hylocereus* sp.)

The French brought the dragon fruit, also known as pitaya, to Vietnam over a century ago **(Mizrahi *et al.*, 1996)**. Because of its high tolerance to challenging climatic conditions, pitaya has been successfully grown in Vietnam's mangrove areas, which is interesting. As a result, it has become a crucial resource for the nation's long-term development, especially in the underdeveloped areas of the Mekong River Delta **(Hoat *et al.*, 2018)**. Dragon fruit is classified as a key export fruit product, bringing in billions of dollars in income value to farmers every year. In 2019, the growing land of dragon fruit was approximately 36.5 thousand hectares and produce around 630 tons of total yield, which led Vietnam to the world's exporter of dragon fruit **(Nguyen *et al.*, 2020)**.The main export markets of Vietnamese dragon fruit are China (accounting for more than 80%), Thailand, and Indonesia. Besides, Vietnamese dragon fruit has also been exported to many other countries such as India, Australia, New Zealand, Japan, the European Union, and Chile. In addition to the traditional dragon fruit with red skin and white flesh, Long An province also has the main product of red flesh dragon fruit. Besides, this province also has developed many varieties of dragon fruit with purple skin and flesh or dragon fruit with yellow skin and white flesh. These fruits are determined to contain high nutritional compounds. The production and processing of dragon fruit are still in the early stages of development and struggle with extreme price swings. The total soluble solid of concentrated red dragon fruit juice from Binh Thuan province in Vietnam was 13.8-60°Brix, and the amounts of total polyphenols, flavonoids, vitamin C, and betacyanins were about 2000 gGAE/mL, 1000 gQE/mL, 100 g/mL, and 80 mg/kg, respectively **(Nguyen *et al.*, 2021)**. The peel from dragon fruit was also a good source of pectin and antioxidant pigment. The study of **Thuy *et al.* (2022c)** showed that red dragon fruit peel contained 22.28 mg/100 mL of betacyanin in the extract under ultrasound-assisted extraction. The chemical structures of betacyanin can be further categorized as betanin, amaranthine, gomphrena, and bougainvillea substances (**Kunnika and Pranee, 2011**). According to **Man et al. (2020)**, betanin (5-O-glucosides) is the main structural component of the red dragon fruit peel and it has strong antiradical properties. Because of this, the red dragon fruit peel has the capacity to color food. In Asia traditional medicine, dragon fruit is also used as herbal medicine in formulas to treat and prevent some diseases such as diabetes, obesity, hyperlipidemia, and cancer **(Le *et al.*, 2021; Sofowora *et al.*, 2013)**. In addition, dragon fruit skin and pulp were also known to be rich sources of fiber and rich in vitamins, and minerals **(Manihuruk *et al.*, 2017; Nurliyana *et al.*, 2010)**. The high fatty acid content of dragon fruit seeds makes them a good source of fat for the body's digestion and absorption processes. According to **Afandi *et al.* (2017)**, the seeds of dragon fruit grown in Malaysia have high concentrations of crucial fatty acids like oleic acid (22.7%), palmitic acid (17.5%), *cis*-vaccenic acid (3.0%), and linoleic acid (50%). Fatty acid content in Vietnam dragon fruit seeds is still lack of information. According to several studies, dragon fruit contains a significant amount of naturally polymers, including proteins and polysaccharides (such as galacturonic acid), which offer active sites in the polymer chain to adsorb particles and promote coagulation **(Choy *et al.*, 2014; García-Cruz *et al.*, 2013; Miller *et al.*, 2008)**. The coagulation ability of dragon fruit peel, which is classified as agricultural waste, has only been studied once, by **Sharifah *et al.* (2018)** to remove turbidity from landfill leachate. Dragon fruit offers several health benefits because of its nutritional and therapeutic qualities, particularly in the management and control of oxidative stress. The stem, flower, peel, and seed of the pitaya are just a few of the numerous parts that contain bioactive substances that have been linked to several advantageous biological functions, including antioxidant capacity, antibacterial activity, and anti-cancer activity. According to studies conducted by **Sharifah *et al.* (2018)**, the bioactive substances found in dragon fruit are all effective, beneficial, secure, and long-lasting substitutes for manufactured drugs. In addition to having therapeutic benefits, pitaya is a natural source of colorants that may be used in the food and cosmetics industries. Dragon fruit has developed into a valuable product for the Vietnamese economy and a catalyst for sustainable development because of its ecological characteristics, advantages to human health, and economic value. Particularly in terms of promoting the sustainable use of ecosystems and biodiversity in the Southwest of Vietnam, the sustainability of agricultural production is more vulnerable to the effects of climate change. Due to the dragon fruit's exceptional adaptation and resilience to a variety of challenging environmental conditions, the trial growth model of climbing this plant in the mangrove area of the Mekong Delta, which is characterized by high temperatures, was successful. Further study is required to determine how to exploit this byproduct from this plentiful and highly adaptable resource to ensure the expansion of sustainable agriculture.

Pineapple (*Ananas comosus*)

Vietnam's agricultural industry, which includes fruits and vegetables, generates a sizeable amount of export goods each year and accounts for 9% of the nation's GDP. According to **Nga and Trang (2015)**, the storage facilities of companies that process fruits and vegetables have an annual capacity of more than 313 thousand tons of goods. One of the most well-known tropical fruits, the pineapple (*Ananas cosmosus*), is available both fresh and processed. Pineapple products could be processed in a variety of ways, from small-scale farms to large-scale industries.

Pineapple juice is a popular product among pineapple goods because of its pleasant flavor **(Rattanathanalerk *et al.*, 2005)**. A key economic value in juice processing is extraction yield **(Barrett *et al.*, 2004)**. This is the ratio between the total solids in the plant material used in the procedure and the soluble extract found in pineapple juice. According to **Nguyen and Le (2012)**, a production line's economic efficiency increases when extraction yield increases and processing loss decreases. The top and bottom of the pineapple are cut during the peeling process (15-20% of the fruit weight), and the skin and eyes of the pineapple, as well as parts of its other components, are removed during the preparation of the fruit for storage, frozen or dried (30-40% of the fruit weight), and the waste obtained after pressing pineapples to extract juice (20–40% of the beginning material's weight). The amount of garbage in the water grows dramatically during harvest season; around 2.5–3.3 million tons of waste accumulate in large reforestation sites, settlements, and plantations **(Trang *et al.*, 2013)**. Biogas can be made from waste from the fruit and vegetable industries, which helps to minimize pollution. Furthermore, these wastes have the potential to be a significant source of renewable energy **(Dubrovskis *et al.*, 2012)**. Environmental concerns are created when pineapple plant waste is burned or allowed to degrade in a landfill (**Tripathi *et al.*, 2013**). This is because CO_2, CO, CH_4, organic volatile chemicals, NO_2, and halogen compounds are generated. Therefore, pineapple plant waste needs to be turned into useful, high-value things rather than being thrown away. Cellulose, hemicellulose, and lignin are the fibers that are created as a byproduct of the production of pineapples (**Norazreen *et al*., 2018**). Pineapple fibers can also be recycled for a variety of other purposes such as food packaging (**Sasikala and Umapathy, 2018**), medical applications (**Kengkhetkit and Amornsakchai, 2012**), automotive and electrical applications (**Hoang *et al.*, 2019**). Young's modulus of the pineapple fibers is the highest when compared to other natural fibers (**Asim *et al*., 2015**). As a result, once the pineapple fibers are changed into a new aerogel material, the structural material of the pineapple fibers can be improved. Long pineapple leaves are stripped of their strong, silky fibers, which are then used to create bio-aerogels in a subsequent step. In a study by **Luu *et al.* (2020)**, isolated pineapple leaf fibers were successfully employed to create eco-friendly and affordable pineapple fiber aerogels by employing polyvinyl alcohol as a cross-linker and a freeze-drying technique. The pineapple fibers aerogels have a very low density and a lot of porosity. The pineapple fibers aerogel has a surface area of up to 5.6 m^2/g and a pore size of 1.3-2.2 nm. The pineapple fibers aerogels are flexible and can be used for building heat insulation as well as food preservation because of their low Young's modulus values. Recently, cellulose aerogel from pineapple leaves was used to remove dyes and oil in wastewater **(Vu *et al.*, 2022)**. The cellulose isolated from pineapple leaves in Ben Tre province, Vietnam, was used to create cellulose-g-poly(acrylic acid), which has a great potential for agricultural usage, particularly in coastal regions facing a developing strand of saltwater intrusion **(Thien *et al.*, 2022)**. Bromelain enzyme from the Vietnamese “Cau Duc” pineapple peel also was extracted by **Thanh *et al.* (2013)**. A high extraction yield of 51.13% by dry mass was achieved when cellulose was successfully extracted from Vietnamese pineapple leaf waste. This study also demonstrates how exciting and practical it is to manufacture bio-superabsorbent in Vietnam using leftover pineapple leaves. According to **Phan *et al.* (2020)** and **Tuyet Phan *et al.* (2021)**, it is also excellent for environmental preservation. Producing a variety of goods, including those used in the food sector, may be achieved through the utilization of agricultural by-products from the production and processing of pineapples **(Chinh *et al.*, 2014)**. By applying appropriate handling and processing measures, this source can generate great profit value, while reducing the impact on the environment, ensuring its sustainability. New and green technologies should also be considered for the extraction of beneficial ingredients for consumers' health in pineapple by-products.

Jackfruit (*Artocarpus heterophyllus*)

Vietnam's middle-part and southern provinces are home to a large jackfruit tree (*Artocarpus heterophyllus*) population. In the food business, jackfruit pulp can be utilized to create a wide range of goods, such as jackfruit chips, cocktails, and many other items that are highly prized in foreign markets. The jackfruit fruit is composed of 31.0% peels, 28.2% pulp, 15.35% seeds, and 25.35% rags. In addition to the pulp, jackfruit rags contain a significant amount of cellulose (20.5%), protein (0.3-0.6%), reducing sugar (1.7-4.50%), total sugar (1-6.8%), and pectin (1.10-1.63%). The demand for jackfruits has recently increased domestically and internationally, which has resulted in an increase in trash like fruit skin, seeds, and rags. In addition to creating a new refreshing product and additional jobs for the farmers, using fruit rags to make fermented drinks reduces the requirement for environmental treatment because of the processing of jackfruit in the food business. Jackfruit seeds can have a protein content that ranges from 5.3% to 6.8% **(Chrips *et al.*, 2008)**. In recent years, there has been a lot of interest in the use of alternative sources of starch in industrial applications. This has led to a lot of interest in jackfruit seeds as a good source of starch (**Mahanta and Kalita, 2015**). According to **Tulyathan *et al.* (2002)**, the recovery yield of starch extracted from jackfruit seeds was around 77%, indicating the possibility of its use as a potent source of starch in the food and pharmaceutical industries (**Kittipongpatana and Kittipongpatana, 2011**), as a stabilizer, thickening, and binding agent. To increase the utilization of fresh seeds, turning them into flour is an excellent strategy (**Mahanta and Kalita, 2015**). Jackfruit seed starch produced in Vietnam has a higher amylose percentage (44%) than other starches, according to **Tran *et al.* (2015).** As prebiotics, jackfruit seeds are suitable due to their non-reducing carbohydrates (**Bhornsmithikun *et al*., 2010**). As jackfruit's outer peel is rich in calcium, pectin, and fiber compounds, using it to produce pectin can increase profits for producers and processors while reducing waste (**Moorthy *et al.*, 2017**). **Begum *et al.* (2014)** investigated how various extraction techniques affected the yield, physicochemical content, and structural traits of pectin obtained from jackfruit waste. The extracted pectin was of inferior quality compared to commercial pectin, having low solubility and a high ash concentration, necessitating more study into the manufacture of high-quality pectin from jackfruit waste with higher solubility. As a result, various research has concentrated on extracting pectin from jackfruit peel using more modern techniques such as extraction with aid of ultrasound **(Moorthy *et al.*, 2017)** and the assistance of ultrasound-microwave to extraction **(Xu *et al.*, 2018)**, which have been shown to give larger pectin-yields-than-traditional approaches. **Dam and Nguyen (2013**) improved the method for creating fermented drinks using jackfruit rags. To transform jackfruit into minimally processed items, correct postharvest techniques were used, which also resulted in the production of fruit waste. Waste from jackfruit needs to be converted into useful items in order to aid in waste administration by producing various goods and renewable energy sources. Further research should be done on finding practical industrial applications for jackfruit as well as proper waste control during jackfruit processing.

Orange *(Citrus sinensis*)

As one of the plants grown in tropical and subtropical climates of the genus *Citrus*, oranges (*Citrus sinensis*) are one of the typical trees, especially in Vietnam. Vietnam is ranked as the top 20 countries supplying the highest number of oranges in the world, serving the beverage processing industry. However, along with the production process, a large amount of orange peel was discarded after the juice extraction process. Recent studies show that orange peels contain many important ingredients that can be reused, such as essential oils and antioxidant compounds. Orange peels come in a variety of colors, including blue, yellow-green, and vivid orange, with numerous oil veins. Limonene (> 85%), cymene, myrcene, pinene, citral, citronellal, nootkatone, n-decanal, n-nonanal, n-dodecanal, and linalyl acetate are among the principal components of the essential oil, which makes up roughly 1.5 percent of the fruit **(Tao *et al.*, 2009)**. These molecules are mostly monoterpene and sesquiterpene hydrocarbons, as well as their oxygen derivatives **(Xiao Nan and Sun Chul, 2013)**. Orange essential oil's potent antibacterial and antifungal properties have recently been discovered to be due to abundant limonene **(Mai, 2020)**. Local research showed that microwave-assisted extraction was effective in the production of essential oil from the orange peel **(Toan *et al.*, 2020; Tran *et al.*, 2020; Tran *et al.*, 2019; Van Tuan *et al.*, 2021)**. Another research was applied vacuum frying on orange peel, which used in candy making **(Hien and Nguyet, 2021)**. These outcomes validated the vacuum frying technique as a means of frying high-quality king orange peel while preserving the oil's quality. Orange oil from the Vietnamese province of Phu Tho contained this antioxidant activity and antimicrobial activity **(Van Loi and Uyen, 2016)**. Orange peel is a potential agricultural by-product that can be reused and widely applied in agricultural industries. By appropriate treatment, extraction and processing methods, this source of agricultural by-products can not only be solved to reduce the burden of environmental pollution but also provide a great economic benefit to the locality.

Pomelo (*Citrus maxima*)

One of the citrus trees, pomelo is native to tropical and subtropical countries including Vietnam. Vietnam is a pomelo-growing country with various varieties, some pomelo varieties can be mentioned such as “Da Xanh” pomelo (Ben Tre), “Nam Roi” pomelo (Vinh Long), “Dien” pomelo (Ha Noi), and “Doan Hung” pomelo (Phu Tho), etc. The growing area of pomelo has been increasing in recent years, for example, the area planted with “Da Xanh” pomelos in Ben Tre province (Southern Vietnam) is currently 8,824 hectares in 2021, accounting for about 30% of the fruit tree area. Pomelo is often consumed in fresh form, eaten directly or some farmers process pomelos into juice; however, the peel is not usually used even though it contains a variety of valuable nutrients and biological compounds. Pomelo peel accounts for 30% of fruit weight **(Zarina and Tan, 2013)**. Flavonoids, which have anti-inflammatory and anticancer characteristics and are crucial in the prevention of cardiovascular disease, diabetes, and other illnesses, are abundant in pomelo peel (**Ke *et al*., 2015; Peterson *et al.*, 2006; Yi *et al.*, 2017**). As a result, pomelo peels could be a cheap and easy source of bioactive compounds for use in the food and pharmaceutical sectors **(Deng *et al.*, 2012)**. Pomelo flavonoids resemble flavanones **(Ke *et al.*, 2015)**. The main components with great antioxidant capacity, sweetness, and flavoring are naringin and hesperidin **(Nogata *et al.*, 2006; Zou *et al.*, 2016)**. According to the research of **Van Hung *et al.* (2020)**, Vietnamese pomelo peel has a high content of phenolics, flavonoids, naringin, and hesperidin. The combined enzyme-ultrasound-assisted extraction technique was found to be the most effective method for extracting bioactive compounds with the best antioxidant and antibacterial activity from pomelo peel, however, it also differed content of biological extraction depending on the pomelo species. Citrus peels are used to make commercial pectin because they have a high pectin content (approximately 20–30%) and are by-products of juice processing **(May, 1990)**. To clean pectic materials of contaminants, ethanol or isopropyl alcohol is used to precipitate the pectic component **(Methacanon *et al.*, 2014)**. Commercial pectin extraction involves the use of hot, diluted acids like hydrochloric or nitric acid, followed by the precipitation of pectic materials with ethanol or isopropyl alcohol and washing with ethanol to eliminate contaminants. Acids are used to break down cell wall materials and separate the contents of cells prior to extraction. The concentration of galacturonic acid in pectin extracted with citric was significantly greater than that of pectin extracted with acetic acid or lactic acid. Citric acid and lactic acid considerably increased the antioxidant capacity of pectin as compared to acetic acid. The isolated pectin from different pomelo types have varied structures. Pure high methoxyl-pectin could be extracted from pomelo peel by-products using an organic solvent, potentially making it a "green" extraction method **(Van Hung *et al.*, 2021)**. Moreover, pomelo peel extract has demonstrated antioxidant properties, suggesting that it could be employed as a supplement in the pharmaceutical and food industries. With EC50 values of 60.89±0.31 g/mL, 60.69±0.21 g/mL, and 24.16±0.06 g/mL for DPPH, ABTS, and FRAP assay, respectively, the extract from Thanh Kieu pomelo (cultivated in Vietnam) peel was shown to have the highest antioxidant activity **(Ha *et al.*, 2022)**.

Passion fruit *(Passiflora edulis)*

Vietnam is a major producer, consumer, and exporter of passion fruit, both fresh and processed. The peel makes up 80% of the weight of passion fruit, resulting in a lot of waste. Rather than reclaiming the garbage, most businesses opt to discard it, polluting the environment and endangering human health. The cellulose and pectin content of passion fruit peels is 42% and 18% dry weight, respectively **(Canteri *et al.*, 2010; Contreras-Esquivel *et al.*, 2010)**. As a result, cellulose and pectin recovery from this waste has a high potential and is extremely practicable. Pectin is a high-value functional food component that is commonly employed as a gelling and stabilizing agent. It's also a plentiful, widespread, and multifunctional component of all land plants' cell walls **(Sharma *et al.*, 2006)**. The most popular starting materials for manufacturing commercial pectin are apple pomace and citrus peels. A novel way to reduce the cost of disposing of biological waste while enhancing the fruit juice processing industry is to recover value from waste generated during the fruit processing process. However, just a few articles have examined the subject of pectin recovery from byproducts of passion fruit **(Locatelli *et al.*, 2019; Sharma *et al.*, 2006)**. However, the majority are high ester pectin **(Kulkarni and Vijayanand, 2010)**. Pectic-oligosaccharide (POS), a new type of prebiotic derived from the partial hydrolysis of pectin, provides several health benefits for people and animals. When compared to highly esterified sources, POS has been shown to have improved biological characteristics when made from low-esterified pectin **(Dongowski *et al.*, 2002)**. Additionally, limited study on the simultaneous extraction of pectin and cellulose from passion fruit peel in Vietnam was found. Finding a workable method to transform the peels into valuable items is therefore important. Pectin and cellulose were successfully extracted from the leftover peel of the passion fruit. Pectin production peaked at 12.60% during the process. To create carboxymethyl cellulose (CMC), the cellulose in the skin of a passion fruit was etherified **(Phan and Ngo, 2020)**. The peel of the passion fruit, cultivated in Vietnam, was utilized in pectin extraction tests after the juice had been extracted. Under optimal conditions, passion fruit peel pectin extraction produced 2.5 g/100 g of fresh peel. The powder pectin extracted from fresh peels has a 95% pectin concentration. Pectin was demonstrated to have a degree of esterification of 35-45% on average and to be free of harmful germs, making it an excellent raw material to produce POS **(Xuan Sam and Huyen, 2018)**.

DEVELOPMENT OF VALUE-ADDED FOOD PRODUCTS FROM WASTE

Sources of agricultural by-products are increasing due to consumer demand. Along with that, researchers are looking for appropriate solutions to make effective use of this resource, including Vietnam. Studies at home and abroad show that by-products contain large amounts of digestible fiber, biologically active compounds, and some compounds with other functional properties. By appropriate processing techniques along with the advancement of modern and advanced production and processing techniques, these by-products will be transformed into value-added products. Organization for Economic Co-operation and Development (OECD) defined the green technology concept in the field of agriculture and agri-food, as “the pursuit of economic growth and development, while preventing environmental degradation, biodiversity loss and unsustainable natural resource use” **(OECD, 2011)**. Over the last decade, food production has mushroomed increased, and it also resulted in many wastes being generated, specifically in Vietnam as above discussed. In general, agricultural waste, especially fruit and vegetable, posed a high content of prebiotics, dietary fiber, carotenoids, fatty acids, phenolic compounds, isoprenoids, lipids, proteins, starch, saponins, and phytoestrogens, as some material already mentioned, making them an important source for development into functional foods, nutraceuticals, and cosmetics **(Deng *et al.*, 2012; Sagar *et al.*, 2018; Thuy *et al.*, 2022d; Thuy *et al.*, 2023b; Thuy *et al.*, 2022e; Thuy *et al.*, 2023c; Thuy *et al.*, 2022f; Vu *et al.*, 2022)**. When key waste problems are solved, it will promote agricultural and economic development, and the food supply chain will also change in a positive direction. New approaches in food processing to ensure sustainability are also proposed. New research and analysis techniques were also developed. At the same time, on the social side, when agricultural resources are effectively used in production and processing, technologies to reduce harmful effects on human health and the environment are proposed, leading to a better life for people are growing **(Thuy *et al.*, 2022g)**. They play a significant role in sustaining human populations' ability to sustainably feed themselves, as well as in guaranteeing the sustainability of agriculture, the environment, and biodiversity.

Dietary fiber and resistant starch as prebiotic sources

Human digestive enzymes can only partially break down dietary fiber, which is a component of food made from plants. Additionally, interest in starch bioavailability and its potential as a source of dietary fiber, particularly in adults, has been rekindled by the idea of resistant starch (RS). Although they can be employed in a variety of meals, the functional features of RS are currently believed to be present **(Sajilata *et al.*, 2006)**. Some research found that various proportions of dietary fibers can be found in all layers of an onion. Three distinct onion cultivars were examined by **Jaime *et al.* (2002)** for their dietary fiber content (skin and interior layers). As a result, the "Grano de Oro" onion had the highest total dietary fiber content (63%) in the skin, while the lowest amount (12%) was found in interior parts. Additionally, the skin of the "Grano de Oro" onion variety had 67% more dietary fibers that were insoluble than the inner part. According to **Benítez *et al.* (2013)**, bagasse also has substantial quantities of dietary fiber, ranging from 36–45%. Unfortunately, there is currently a paucity of knowledge on the dietary fiber content of Vietnamese onion or shallot skins. About 70.6 percent of all dietary fibers, the bulk of which were insoluble, were derived from pineapple shells. Xylose and glucose make up most of the natural sugars present in fiber products **(Sagar *et al.*, 2018; Wu and Shiau, 2015)**. Due to the polyphenol myricetin, pineapple fiber has been discovered to have increased antioxidant activity. Fiber from apples and citrus had noticeably less antioxidant action. The natural flavor and color of pineapple dietary fiber have been noted, which may increase consumer acceptance of the product as a fiber supplement **(Sagar *et al.*, 2018)**. A powdered beverage that was enriched with dietary fiber from pineapple peel was the subject of an earlier study by **Larrauri *et al.* (1997)**. High-quality, organoleptically suitable crushed and powdered (formed into flour) pineapple peels with an 8% moisture content were combined with sugar, citric acid, flavor, color, and a foaming agent to create a special drink mix. Due to the presence of 25% dietary fiber, cellulose, and hemicelluloses (17–18%), up to 17% pectic components, and lignin between 2-3% in the pulp and peels of orange wastes created during the juice extraction process, this beverage mixture had a laxative effect **(Mahato *et al.*, 2019)**. There were 22% soluble and 54% insoluble dietary fibers in citrus fiber produced from orange juice. Citrus fiber was low in calories, very good at absorbing oil, and had a large water storage capacity. Orange fiber is recommended as a pulp source for drinks (cloudy drinks), a gelling agent, a binder for low-calorie bulking, and a thickening agent **(Lundberg *et al.*, 2014; Rafiq *et al.*, 2018)**. Citrus dietary fiber's organoleptic qualities have been shown in studies to have no negative effects on food properties. Dairy products, infant foods, beverages, soups, fruit juices, and desserts are among the approved uses **(Dervisoglu and Yazici, 2006)**. Insoluble dietary fiber made up 47.6% of the total amount of dietary fiber found in orange peels from the "Liucheng" variety, whereas soluble dietary fiber made up 9% of the dry weight. Cellulose and pectic polysaccharides were found to be the main components of these substances. With a total dietary fiber content of 14% (dry weight), lemon peels are approximately twice as high in fiber as lemons that have been peeled (7 percent dry weight) **(Gorinstein *et al.*, 2001; Lundberg *et al.*, 2014)**. The percentages of total dietary fibers that were soluble and insoluble, respectively, were 5% and 9%. Both soluble and insoluble dietary fibers were present in large amounts in lemon pulp and peel. Contrarily, there was much more dietary fiber in the pulp (78%) than in the peel (53%) of orange (*Citrus sinensis*) **(Lundberg *et al.*, 2014)**.

Enzyme production

Enzymes are one of the efficient strategies in the green technology revolution for catalyzing the process. Because of its high fidelity and, more crucially, high productivity in the reaction process, enzyme catalysis is a vital method for many sorts of crucial applications, and enzymes are frequently seen as suitable tools that are most likely to improve biotechnology. This method of using agricultural waste to produce products with additional value is also one of the more efficient ones. Many bacterial species found in agricultural waste create enzymes that find use in a variety of industries, including food, medicine, textiles, and dyes. Current research demonstrates that one of the most successful strategies for preparing the environment for climate change is biotechnology. Studies using waste by-products as substrates or substrates to create enzymes are still not widespread in Vietnam. However, the research by **Jahan *et al.* (2017)** aimed to create useful biocatalysts using agricultural waste (apple peels, orange peels, lemon peels, potato skins, and wheat bran). This study demonstrates that *Bacillus licheniformis* KIBE-IB3, which generates the most proteoglycanase (PGase), can create the greatest amounts of PGase when given the right nutrients **(Jahan *et al.*, 2017)**. The different ingredients support microbial growth because fermentation is what constitutes agricultural waste, which leads to the production of valuable enzymes. Throughout the industrial process, waste is employed as a raw material. Due to the degradation of many enzymes by the substrates found in these raw materials, the lignocellulose substrate is transformed from a complex material to a less complex one by fungal growth. Additionally, it has been demonstrated that pectinase may be obtained for a low cost and with ease from rice bran, especially in nations like Vietnam that produce a lot of rice each year. Using B. *subtilis* CBTK 106, banana waste was employed as a substrate for high-titer -amylase synthesis. Banana stem was prepared by steaming at 121°C for 60 min to serve as a suitable carbon source for the creation of cellulase. Moreover, a strain of *Saccharomyces cerevisiae* was identified from agricultural waste in Vietnam and used for the manufacture of alcohol. By rupturing the alpha-1,4 bonds present in starch, amyloglucosidases, often referred to as glucoamylases, can release glucose molecules. In their investigation into the viability of employing banana peels for T. *viride* GIM 3.0010 to produce cellulase in solid-state fermentation, **Sun *et al.* (2011)** found that the peels give the producing organism vital nutrients, leading to high enzyme yields. Xylanases degrade the polysaccharide found in plants called xylan, which has a wide range of industrial applications. A. *niger* growth and, consequently, the production of phytase was dramatically accelerated using rice bran in recent research. Agricultural by-products are used to produce ellagitannase, an enzyme used to biodegrade the production of ellagic acid and ellagitannin **(Buenrostro-Figueroa *et al.*, 2014; Yin *et al.*, 2013)**. Similarly, **Saharan *et al.* (2017)** investigated how fermentation affected phenols, flavonoids, and the ability of popular foods to scavenge free radicals. In addition, they investigated how the enzymes α-amylase, xylanase, and α-glucosidase affect the release of polyphenols and antioxidants from cereals during solid-state fermentation. The results showed that fermentation increased enzyme activity and at the same time increased polyphenol content. Therefore, several techniques that do not use synthetic enzymes have been used, such as the fermentation of xylanase, glucosidase, and lipase from a peanut press by *A. oryzae*. The end outcome was a striking increase in enzyme activity across all studies **(Oliveira *et al.*, 2017)**. Many companies are using industrial enzymes, according to extensive studies on the subject. Many sectors are now starting to look at the benefits of enzymes made from agricultural waste. Due to its high fidelity and, more significantly, high yield in the reaction process, enzyme catalysis is a crucial method for a range of vital applications. Enzymes are occasionally viewed as the biotechnology industry's most flexible tool. A vast spectrum of enzymes used in food, medicine, textiles, and color creation is produced by microbes from agricultural waste.

Functional and preservative compounds

Bioactive compounds, including dietary fibers, have been extensively studied in fruit and vegetable wastes and by-products such as banana peel, orange peel, and pomelo peel…. Locally, some researchers have investigated that agriculture waste in Vietnam posed a high content of antioxidant compounds which led to many functional properties. Specifically, "Vinh Chau" shallot skin has a high content of quercetin and its derivatives as quercetin-glucoside and methylated-quercetin-hexose. Shallot extract contains a high concentration of quercetin-mono-glycoside (43.8% and 35.3%, respectively, in the flesh and skin). Quercetin-di-glucoside was present in considerable concentrations in the meat extract (38.9%). The peel and flesh of shallot bulbs contained 14–16% of methylated quercetin(-glucoside) **(Tai and Thuy, 2023; Thuy *et al.*, 2020)**. Moreover, the skin of the Vietnam red dragon fruit has a high betacyanin concentration of 22.28 mg/g. The food sector may use the obtained result to create a natural food color for the next processing **(Thuy *et al.*, 2022d)**. Fruits and vegetables, which contain phenolics, carotenoids, anthocyanins, and tocopherols, have also been found to have the ability to fight against cancer and other detrimental diseases caused by free radicals **(Caleja *et al.*, 2017; Poljsak and Milisav, 2018)** and also, could potential to reduce the glycemic index of food **(Ngo *et al.*, 2022)**. The anti-aging, anti-inflammatory, and anti-cancer properties of β-carotene, ascorbic acid, and several phenolic compounds are well known **(Ha *et al.*, 2022; Nurliyana *et al.*, 2010)**. Bananas are a common fruit growing in Vietnam that are eaten when they are ripe or utilized in recipes. Many types of bacteria are susceptible to the antimicrobial effects of banana peel extracts in certain recent studies **(Rahman *et al.*, 2019)**. This material can be recovered by using its high-value molecules such as the antioxidant compound and the dietary fiber fraction, which have a lot of promise for use in the production of functional meals. So, producing microbial chemicals effectively from cheap agro-industrial waste can have positive effects on the environment and the economy. For the microbial compounds produced, these agro-waste leftovers can act as a source of glucose. Using a variety of microbial sources, such as bacteria, yeasts, mold, and algae, agro-waste can be fermented into microbial pigments or edible colorants. Agricultural waste is a cheap and useful source for creating commodities with added value that are renewable. This waste can be used to create a range of biological flavoring agents by microbial origin bioconversion. Due to its environmental friendliness, vanillin is one of the most essential flavoring chemicals in the food industry **(Mishra *et al.*, 2013)**. Research into the manufacture of ferulic acid from agro-food industry wastes and by-products has yielded promising results in previous years. Byproducts of the cereal sector, such as rice, maize, wheat, and sugar beet pulp, have been investigated as a potential source of ferulic acid, which has been recovered at maximum yield from these wastes **(Sibhatu *et al.*, 2021)**. **Górnaś *et al.* (2015a)** studied the phenolic compounds found in crab apple pomace flesh, seeds, and stems, and found that seeds had the highest polyphenol concentration (3592.6–23,606.8 mg/kg). Eleven apple seed oils prepared from leftovers from the production of juice and fruit salads were studied by **Górna *et al.* (2014)** for their lipophilic composition. According to this study, palmitic, oleic, and linoleic acids make up the majority of the fatty acids in apple seeds. From 12 to 27 g/100 g of oil were produced. Tocotrienols and tocopherols are present in high concentrations in seed oils generated from industrial fruit waste and by-products **(Górnaś *et al.*, 2015b)**. Watermelon seeds contained high content of phytosterol, which accounted for around 28% **(Górnaś and Rudzińska, 2016)**. The tocochromanol profile in the seed oils of industrial by-products from five dessert apples and seven crab varieties raised in Latvia was also examined by **Górna (2015)**. Ascorbic acid, often known as vitamin C, is a naturally occurring vitamin that is found in many different plant sections. It is the best biochemical that might be used in the food industry, and it has long been known about it. Current methods largely use it as a natural biomedicine and food preservative **(Ayala-Zavala *et al.*, 2009)**. Many antimicrobial food packaging techniques, such as bioactive extracts of citrus species bio-waste, have been employed to preserve diverse foods by inhibiting a wide range of microorganisms that cause degradation without affecting the quality and functional features **(McClements *et al.*, 2021)**. The addition of food tastes and preservative chemicals generated from various agricultural wastes to processed foods enhances the flavor, experience, and overall satisfaction of a variety of goods. Yet research has demonstrated that there are no unfavorable effects from including these flavors and related compounds in food **(McClements *et al.*, 2021)**.

Other products

Each year, a large amount of organic waste is released by agricultural and industrial operations. Sugar and carbohydrate content are common in these wastes **(Kim *et al.*, 2019)**. Moisture, nutrients, and significant volumes of carbon are readily available and can be successfully utilized to produce a range of high-value goods. It is crucial to look for low-cost and innovative alternatives to the synthesis of citric acid from waste due to the continuously growing demand for the substance. Over 90% of the citric acid traded on the global market is produced globally by fermenting agro-industrial waste products. As it is easy to use, consumes less energy, and is very practical, this is advantageous **(Galanakis, 2018)**. Pine waste produces biomass-assisted citric acids more efficiently than apple pomace. The commercial citrus juice extraction facilities annually produce tons of organic waste residue, peels, and segment membranes **(Santiago *et al.*, 2020)**. The stench pollutes the air, and the discarded wastes pollute soil and the environment. Food color is one of the characteristics that have a significant impact on sensory value, particularly consumer appeal. Red dragon fruit is one possible component. H. *polyrhizus* has high content of minerals like potassium, magnesium, and calcium in addition to being high in organic acids, protein, phosphorus, vitamin C, moisture, and fiber **(Delgado-Vargas *et al.*, 2000)**. At least seven betacyanins, which are responsible for the intense purple-red color of the flesh and peel, have been specifically found in this material by **Rebecca *et al.* (2010)**. H. *polyrhizus* betacyanin has a lot of potential for coloring a variety of foods, and they could be employed not only as colorants but also as antioxidants **(Castellar *et al.*, 2003)**. According to **Rodriguez *et al.* (2015)**, the red dragon fruit's skin contains 30.18 mg/100 g of fresh peel and 42.71 mg/100 g of fresh pulp, respectively, of the health-promoting betacyanin. From this source, betacyanin can be extracted and used as a natural food colorant (red purple) as well as a source for natural health and beauty products. This minimizes food waste. By increasing the fruit's monetary value and promoting a sustainable economy, using the pulp and peel also reduces pollution. Betacyanin is a natural colorant with a significant molecular absorption index and coloring potential.

In addition to the food industry, agricultural wastes, fruits and vegetables are used to compost as bio-fertilizer, used in growing vegetables and supplementing clean food for the family and increasing income. This method not only works to treat the odor of waste, reduces pollution, but also helps reduce fertilizer costs, producing clean vegetables for use in meals. In Vietnam, a very common waste product is rice husk, which was previously considered a waste, causing many difficulties for rice processing plants. With an output of more than 25 million tons of rice per year, after milling, the Mekong Delta produces more than 1.5 million tons of rice husk **(Song *et al.*, 2021)**. Moreover, in the process of growing sugarcane, humus and bagasse are released annually around millions of tons. These are all abundant sources of raw materials for people to reuse in the agricultural production process. According to studies, the amount of nutrients contained in 7 tons of rice straw if used to make organic fertilizer is equivalent to 2 bags of urea, 1 bag of phosphorus and 4 bags of potassium. In fact, Vietnam's demand for organic fertilizers is very high, but the price of chemical fertilizers has increased and the impact of climate change on agricultural production is increasingly serious. Therefore, the exploitation of raw materials from agricultural waste is considered an important direction, in line with the current trend of green and clean agriculture development.

CONCLUSION

This review has summarized some common agricultural by-products in Vietnam, and relevant domestic and foreign studies on the sources of by-products. The source of agricultural by-products in Vietnam is very large because the consumer demand for agricultural products is also increasing. However, these sources have not yet been used appropriately. Agricultural by-products are rich in nutrients such as resistant starch, biologically active compounds, essential oils, and pectin, which can be processed into many different products. By applying green technologies and techniques, this source of raw materials can contribute great value to industries, especially the food industry in Vietnam. However, these technologies need to be standardized and optimized in the future to ensure safety, quality, and savings. Techniques for the application of value-added products from agricultural by-products also need to be developed and perfected, while meeting the needs of society. The opportunities for research and development of agricultural by-products in Vietnam are huge, however, it needs to consider more about appropriate technology to fill the gaps and process to upscale. The by-products, especially after the COVID-19 pandemic, contain important biological resources that can be used to boost the user's immune system and provide other health benefits in the future. It is necessary to have specific plans such as methods of collection and treatment of agricultural products, by-product management, techniques applied to optimize the use of by-products, and the application of value-added products. Environmental impact assessment, social needs, and economic analysis are also necessary steps in optimizing agricultural waste in Vietnam. Sustainable agriculture can not only help reduce environmental pollution but also improve people's living standards.

REFERENCES

Afandi, A., mat lazim, A., Zakaria, N., Bakar, M., Othman, B.-A., & Fazry, S. (2017). Antibacterial properties of crude aqueous *Hylocereus polyrhizus* peel extracts in lipstick formulation against gram-positive and negative bacteria. *Malaysian Applied Biology*, *46*, 29-34.

Ayala-Zavala, J. F., González-Aguilar, G. A., & del-Toro-Sánchez, L. (2009). Enhancing safety and aroma appealing of fresh-cut fruits and vegetables using the antimicrobial and aromatic power of essential oils. *Journal of Food Science, 74*(7), R84-91. http://dx.doi.org/10.1111/j.1750-3841.2009.01294.x

Barrett, D. M., Somogyi, L., & Ramaswamy, H. S. (2004). *Processing fruits: science and technology*. CRC press. http://dx.doi.org/10.1201/9781420040074

Bashmil, Y. M., Ali, A., Bk, A., Dunshea, F. R., & Suleria, H. A. R. (2021). Screening and characterization of phenolic compounds from Australian grown bananas and Their antioxidant capacity. *Antioxidants*, *10*(10), 1521. http://dx.doi.org/10.3390/antiox10101521

Begum, R., Aziz, M. G., Uddin, M. B., & Yusof, Y. A. (2014). Characterization of jackfruit (*Artocarpus heterophyllus*) waste pectin as influenced by various extraction conditions. *Agriculture and Agricultural Science Procedia*, *2*, 244-251. http://dx.doi.org/10.1016/j.aaspro.2014.11.035

Benítez, V., Mollá, E., Martín-Cabrejas, M. A., Aguilera, Y., López-Andréu, F. J., Terry, L. A., & Esteban, R. M. (2013). The impact of pasteurisation and sterilisation on bioactive compounds of onion by-products. *Food and Bioprocess Technology*, *6*(8), 1979-1989. http://dx.doi.org/10.1007/s11947-012-0866-x

Bhornsmithikun, V., Chetpattananondh, P., Yamsaengsung, R., & Prasertsit, K. (2010). Continuous extraction of prebiotics from jackfruit seeds. *Songklanakarin Journal of Science and Technology*, *32*(6), 635-642.

Bigdeloo, M., Teymourian, T., Kowsari, E., Ramakrishna, S., & Ehsani, A. (2021). Sustainability and circular economy of food wastes: Waste reduction strategies, higher recycling methods, and improved valorization. *Materials Circular Economy*, *3*(1), 3. https://dx.doi.org/10.1007/s42824-021-00017-3

Buenrostro-Figueroa, J., Ascacio-Valdés, A., Sepúlveda, L., De la Cruz, R., Prado-Barragán, A., Aguilar-González, M. A., Rodríguez, R., & Aguilar, C. N. (2014). Potential use of different agroindustrial by-products as supports for fungal ellagitannase production under solid-state fermentation. *Food and Bioproducts Processing*, *92*(4), 376-382. http://dx.doi.org/10.1016/j.fbp.2013.08.010

Caleja, C., Ribeiro, A., Filomena Barreiro, M., & CFR Ferreira, I. (2017). Phenolic compounds as nutraceuticals or functional food ingredients. *Current Pharmaceutical Design*, *23*(19), 2787-2806. http://dx.doi.org/10.2174/1381612822666161227153906

Canteri, M. H., Scheer, A. P., Petkowitz, C., Ginies, C., Renard, C., & Wosiacki, G. (2010). Physicochemical composition of the yellow passion fruit pericarp fractions and respective pectic substances. *Journal of Food and Nutrition Research*, *49*(3), 113-122.

Castellar, R., Obón, J. M., Alacid, M., & Fernández-López, J. A. (2003). Color properties and stability of betacyanins from Opuntia fruits. *Journal of Agricultural and Food Chemistry*, *51*(9), 2772-2776. http://dx.doi.org/10.1021/jf021045h

Chinh, T. T., Ninh, T. H., & Dung, H. T. (2014). Isolation of some thermophylic and acid-resistant Actinomyces strains biosynthesizing cellulase from pineapple waste. *Academia Journal of Biology*, *28*(4), 63-67. http://dx.doi.org/10.15625/0866-7160/v28n4.5346

Cho, E. J., Trinh, L. T. P., Song, Y., Lee, Y. G., & Bae, H. J. (2020). Bioconversion of biomass waste into high value chemicals. *Bioresource Technology*, *298*, 122386. http://dx.doi.org/10.1016/j.biortech.2019.122386

Choy, S. Y., Prasad, K. M. N., Wu, T. Y., Raghunandan, M. E., & Ramanan, R. N. (2014). Utilization of plant-based natural coagulants as future alternatives towards sustainable water clarification. *Journal of environmental sciences*, *26*(11), 2178-2189. http://dx.doi.org/10.1016/j.jes.2014.09.024

Chrips, N. R., Balasingh, R. G. S., & Kingston, C. (2008). Nutrient constituens of negleted varieties of *Artocarpus heterophyllus* Lam. from Kanyakumari district, South India. *Journal of basic and applied biology*, *2*(1), 36-47.

Cong, T. Q. (2016). Feasibility of cleaner production for Vietnam rice processing industry. *Procedia CIRP*, *40*, 285-288. http://dx.doi.org/10.1016/j.procir.2016.01.122

Contreras-Esquivel, J. C., Aguilar, C. N., Montañez, J., Brandelli, A., Espinoza-Perez, J. D., & Renard, C. M. G. C. (2010). Pectin from passion fruit fiber and its modification by pectinmethylesterase. *Journal of Food Science and Nutrition*, *15*, 57-66. http://dx.doi.org/10.3746/jfn.2010.15.1.057

Dam, S. M., & Nguyen, N. T. (2013). Production of fermented beverage from fruit rags of jackfruit (*Artocarpus heterophyllus*). Southeast Asia Symposium on Quality Management in Postharvest Systems and Asia Pacific Symposium on Postharvest Quality,

Delgado-Vargas, F., Jiménez, A. R., & Paredes-López, O. (2000). Natural pigments: carotenoids, anthocyanins, and betalains--characteristics, biosynthesis, processing, and stability. *Critical Reviews in Food Science and Nutrition*, *40*(3), 173-289. http://dx.doi.org/10.1080/10408690091189257

Deng, G.-F., Shen, C., Xu, X.-R., Kuang, R.-D., Guo, Y.-J., Zeng, L.-S., Gao, L.-L., Lin, X., Xie, J.-F., & Xia, E.-Q. (2012). Potential of fruit wastes as natural resources of bioactive compounds. *International Journal of Molecular Sciences*, *13*(7), 8308-8323. http://dx.doi.org/10.3390/ijms13078308

Dervisoglu, M., & Yazici, F. (2006). Note. The Effect of Citrus Fibre on the Physical, Chemical and Sensory Properties of Ice Cream. *Food Science and Technology International*, *12*(2), 159-164. http://dx.doi.org/10.1177/1082013206064005

Dongowski, G., Lorenz, A., & Proll, J. (2002). The degree of methylation influences the degradation of pectin in the intestinal tract of rats and *in vitro*. *Journal of Nutrition*, *132*(7), 1935-1944. http://dx.doi.org/10.1093/jn/132.7.1935

Dubrovskis, V., Plume, I., Kazulis, V., Celms, A., Kotelenecs, V., & Zabarovskis, E. (2012). Biogas production potential from agricultural biomass and organic residues in Latvia. *Engineering for Rural Development*, *11*, 566-571.

Fries, J. H., & Waldron, R. J. (1950). Dehydrated banana in the dietetic management of diarrheas of infancy. *The Journal of Pediatrics*, *37*(3), 367-372. http://dx.doi.org/10.1016/S0022-3476(50)80156-7

Galanakis, C. M. (2018). 12 - Food Waste Recovery: Prospects and Opportunities. In C. M. Galanakis (Ed.), *Sustainable Food Systems from Agriculture to Industry* (pp. 401-419). Academic Press. http://dx.doi.org/10.1016/B978-0-12-811935-8.00012-3

Galanakis, C. M., Rizou, M., Aldawoud, T. M. S., Ucak, I., & Rowan, N. J. (2021). Innovations and technology disruptions in the food sector within the COVID-19 pandemic and post-lockdown era. *Trends in Food Science & Technology*, *110*, 193-200. http://dx.doi.org/10.1016/j.tifs.2021.02.002

García-Cruz, E., Rodriguez-Ramirez, J., Lagunas, L. M., & Medina-Torres, L. (2013). Rheological and physical properties of spray-dried mucilage obtained from *Hylocereus undatus* cladodes. *Carbohydrate polymers*, *91*(1), 394-402. http://dx.doi.org/10.1016/j.carbpol.2012.08.048

Gore, M. A., & Akolekar, D. (2003). Evaluation of banana leaf dressing for partial thickness burn wounds. *Burns*, *29*(5), 487-492. http://dx.doi.org/10.1016/S0305-4179(03)00050-0

Gorinstein, S., Martín-Belloso, O., Park, Y.-S., Haruenkit, R., Lojek, A., Ĉíž, M., Caspi, A., Libman, I., & Trakhtenberg, S. (2001). Comparison of some biochemical characteristics of different citrus fruits. *Food chemistry*, *74*(3), 309-315. http://dx.doi.org/10.1016/S0308-8146(01)00157-1

Górnaś, P. (2015). Unique variability of tocopherol composition in various seed oils recovered from by-products of apple industry: Rapid and simple determination of all four homologues (α, β, γ and δ) by RP-HPLC/FLD. *Food chemistry*, *172*, 129-134. http://dx.doi.org/10.1016/j.foodchem.2014.09.051

Górnaś, P., & Rudzińska, M. (2016). Seeds recovered from industry by-products of nine fruit species with a high potential utility as a source of unconventional oil for biodiesel and cosmetic and pharmaceutical sectors. *Industrial Crops and Products*, *83*, 329-338. http://dx.doi.org/10.1016/j.indcrop.2016.01.021

Górnaś, P., Mišina, I., Olšteine, A., Krasnova, I., Pugajeva, I., Lācis, G., Siger, A., Michalak, M., Soliven, A., & Segliņa, D. (2015a). Phenolic compounds in different fruit parts of crab apple: Dihydrochalcones as promising quality markers of industrial apple pomace by-products. *Industrial Crops and Products*, *74*, 607-612. http://dx.doi.org/10.1016/j.indcrop.2015.05.030

Górnaś, P., Rudzińska, M., & Segliņa, D. (2014). Lipophilic composition of eleven apple seed oils: A promising source of unconventional oil from industry by-products. *Industrial Crops and Products*, *60*, 86-91. http://dx.doi.org/10.1016/j.indcrop.2014.06.003

Górnaś, P., Soliven, A., & Segliņa, D. (2015b). Seed oils recovered from industrial fruit by-products are a rich source of tocopherols and tocotrienols: Rapid separation of α/β/γ/δ homologues by RP-HPLC/FLD. *European Journal of Lipid Science and Technology*, *117*(6), 773-777. http://dx.doi.org/10.1002/ejlt.201400566

Gustavsson, J., Cederberg, C., Sonesson, U., Otterdijk, R., & Meybeck, A. (2011). Global Food Losses and Food Waste- Extent, Causes and Prevention. *Proceedings of the Save Food Congress*. *https://www.fao.org/3/i2697e/i2697e.pdf*

Ha, T. T., Mai, T. N. P., Tran, T. T., Nguyen, N. H. K., Le, T. D., & Nguyen, V. M. (2022). Antioxidant activity and inhibitory efficacy of Citrus grandis peel extract against carbohydrate digestive enzymes *in vitro*. *Food Science and Technology*, *42*, e109721. http://dx.doi.org/10.1590/fst.10972

Hien, D. T., & Nguyet, H. T. M. (2021). Effects of vacuum frying on the quality of king orange peel in manufacture of chocolate candy fillings. *Food Science and Applied Biotechnology*, *4*(2), 156-165. http://dx.doi.org/10.30721/fsab2021.v4.i2.110

Hiền, N. T. M., & Thủy, N. M. (2014). Tương quan giữa hàm lượng acid acetic sinh ra và ethanol, đường, mật số vi khuẩn *A. Aceti* trong sản xuất giấm vang chuối [The relationship between acetic acid content and ethanol, sugar, bacteria in the production of banana vinegar]. *Can Tho Unversity Journal of Science*, *Agricututre*(1), 76-83.

Hoang, H. A., Luu, Q. H., Le, P. T. K., & Tran, V. T. (2019). Enhancement of Pineapple Residue Composting by Food Waste Addition. *Chemical Engineering Transaction*, *72*, 217-222.

Hoat, T. X., Quan, V. M., Hien, N. T. T., Ngoc, N. T. B., Minh, H., & Thanh, N. V. L. (2018). *Dragon Fruit production in Vietnam: Achievements and challenges* https://ap.fftc.org.tw/article/1292

Hương, Đ. (2021). *Phụ phẩm nông nghiệp: Nguồn tài nguyên đang bị lãng phí*. Vietnam: *https://baochinhphu.vn/phu-pham-nong-nghiep-nguon-tai-nguyen-dang-bi-lang-phi-102300165.htm*

Jahan, N., Shahid, F., Aman, A., Mujahid, T. Y., & Qader, S. A. U. (2017). Utilization of agro waste pectin for the production of industrially important polygalacturonase. *Heliyon*, *3*(6), e00330. http://dx.doi.org/10.1016/j.heliyon.2017.e00330
Jaichakan, P., Nhung, D. T. H., Nakphaichit, M., & Klangpetch, W. (2019). Intensification of cellulolytic hydrolysis of rice husk, rice straw, and defatted rice bran by sodium hydroxide pretreatment. *Food and Applied Bioscience Journal*, *7*(3), 172-183.
Jaime, L., Mollá, E., Fernández, A., Martín-Cabrejas, M. A., López-Andréu, F. J., & Esteban, R. M. (2002). Structural Carbohydrate Differences and Potential Source of Dietary Fiber of Onion (*Allium cepa* L.) Tissues. *Journal of Agricultural and Food Chemistry*, *50*(1), 122-128. http://dx.doi.org/10.1021/jf010797t
Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). *What a waste 2.0: a global snapshot of solid waste management to 2050*. World Bank Publications. http://dx.doi.org/10.1596/978-1-4648-1329-0
Ke, Z., Xu, X., Nie, C., & Zhou, Z. (2015). Citrus flavonoids and human cancers. *Journal of Food and Nutrition Research*, *3*(5), 341-351. https://doi.org/10.12691/jfnr-3-5-9
Kengkhetkit, N., & Amornsakchai, T. (2012). Utilisation of pineapple leaf waste for plastic reinforcement: 1. A novel extraction method for short pineapple leaf fiber. *Industrial Crops and Products*, *40*, 55-61. http://dx.doi.org/10.1016/j.indcrop.2012.02.037
Kim, H. M., Choi, I. S., Lee, S., Yang, J. E., Jeong, S.-G., Park, J. H., Ko, S. H., Hwang, I. M., Chun, H. H., Wi, S. G., Kim, J.-C., & Park, H. W. (2019). Biorefining Process of Carbohydrate Feedstock (Agricultural Onion Waste) to Acetic Acid. *ACS Omega*, *4*(27), 22438-22444. https://doi.org/10.1021/acsomega.9b03093
Kittipongpatana, O. S., & Kittipongpatana, N. (2011). Preparation and physicochemical properties of modified jackfruit starches. *LWT-Food Science and Technology*, *44*(8), 1766-1773. http://dx.doi.org/10.1016/j.lwt.2011.03.023
Kulkarni, S., & Vijayanand, P. (2010). Effect of extraction conditions on the quality characteristics of pectin from passion fruit peel (*Passiflora edulis f. flavicarpa* L.). *LWT-Food Science and Technology*, *43*(7), 1026-1031. http://dx.doi.org/10.1016/j.lwt.2009.11.006
Kumar, K. S., Bhowmik, D., Duraivel, S., & Umadevi, M. (2012). Traditional and medicinal uses of banana. *Journal of Pharmacognosy and Phytochemistry*, *1*(3), 51-63.
Kunnika, S., & Pranee, A. (2011). Influence of enzyme treatment on bioactive compounds and colour stability of betacyanin in flesh and peel of red dragon fruit *Hylocereus polyrhizus* (Weber) Britton and Rose. *International Food Research Journal*, *18*(4), 1437-1448.
Larrauri, J. A., Rupérez, P., & Calixto, F. S. (1997). Pineapple Shell as a Source of Dietary Fiber with Associated Polyphenols. *Journal of Agricultural and Food Chemistry*, *45*(10), 4028-4031. http://dx.doi.org/10.1021/jf970450j
Lê, T. K. L., Nguyễn, T. K. H. n., Trần, T. T. y. N., & Nguyễn, M. T. y. (2021). Tối ưu hóa quá trình trích ly anthocyanin trong cám gạo cẩm bằng sóng siêu âm. Hội nghị Công nghệ sinh học toàn quốc, Thai Nguyen University, Vietnam.
Le, T.-L., Huynh, N., & Quintela-Alonso, P. (2021). Dragon fruit: A review of health benefits and nutrients and its sustainable development under climate changes in Vietnam. *Czech Journal of Food Sciences*, *39*(2), 71-94. http://dx.doi.org/10.17221/139/2020-CJFS
Li, T., Wu, Q., Zhu, H., Zhou, Y., Jiang, Y., Gao, H., & Yun, Z. (2019). Comparative transcriptomic and metabolic analysis reveals the effect of melatonin on delaying anthracnose incidence upon postharvest banana fruit peel. *BMC plant biology*, *19*(1), 1-15. http://dx.doi.org/10.1186/s12870-019-1855-2
Liên, T. n. N. c., & Thuỷ, N. n. M. (2016). Thu nhận dịch đường glucose từ quá trình thủy phân cám gạo (giống IR5451) bằng phương pháp enzyme. *Tạp chí Khoa học Trường Đại học Cần Thơ, CĐ Nông nghiệp 2016*, 113-121. http://dx.doi.org/10.22144/ctu.jsi.2016.029
Loan, L. T. K., Thuy, N. M., & Tai, N. V. (2023). Mathematical and artificial neural network modeling of hot air-drying kinetics of instant "Cẩm" brown rice. *Food Science and Technology*, *43*, e27623. http://dx.doi.org/10.1590/fst.27623
Locatelli, G. O., Finkler, L., & Finkler, C. L. (2019). Orange and passion fruit wastes characterization, substrate hydrolysis and cell growth of Cupriavidus necator, as proposal to converting of residues in high value added product. *Anais da Academia Brasileira de Ciências*, *91*(1), e20180058. http://dx.doi.org/10.1590/0001-3765201920180058
Lopes, S., Borges, C. V., de Sousa Cardoso, S. M., de Almeida Pereira da Rocha, M. F., & Maraschin, M. (2020). Banana (*Musa* spp.) as a source of bioactive compounds for health promotion. *Handbook of Banana Production, Postharvest Science, Processing Technology, and Nutrition*, 227-244. http://dx.doi.org/10.1002/9781119528265.ch12
Lundberg, B., Pan, X., White, A., Chau, H., & Hotchkiss, A. (2014). Rheology and composition of citrus fiber. *Journal of Food Engineering*, *125*, 97-104. http://dx.doi.org/10.1016/j.jfoodeng.2013.10.021
Luu, T. P., Do, N. H. N., Chau, N. D. Q., Lai, D. Q., Nguyen, S. T., Le, D., Thai, Q. B., Le, P. K., & Duong, H. M. (2020). Morphology control and advanced properties of bio-aerogels from pineapple leaf waste. *Chemical Engineering Transaction*, *78*, 433-438.
Ly, H. L., Tran, T. M. C., Tran, T. T. T., Ton, N. M. N., & Le, V. V. M. (2018). Application of ultrasound to protein extraction from defatted rice bran. *International Food Research Journal*, *25*(2), 695-701.
Mahanta, C. L., & Kalita, D. (2015). Processing and utilization of jackfruit seeds. In *Processing and impact on active components in food* (pp. 395-400). Elsevier. http://dx.doi.org/10.1016/B978-0-12-404699-3.00047-0
Mahato, N., Sinha, M., Sharma, K., Koteswararao, R., & Cho, M. H. (2019). Modern Extraction and Purification Techniques for Obtaining High Purity Food-Grade Bioactive Compounds and Value-Added Co-Products from Citrus Wastes. *Foods*, *8*(11), 523. http://dx.doi.org/10.3390/foods8110523
Mai, C. (2020). Effect of Storage Conditions on the Chemical Composition of Vietnamese Clove (*Syzygium aromaticum*) Essential Oil. *Journal of Global Pharma Technology*, *12*, 447-454.
Man, P. V., Duy, T. D., Hai, D. T. T., & Hai, T. C. (2020). Comparison of ultrasound assisted extraction and enzyme assisted extraction of betacyanin from red dragon fruit peel. *E3S Web of Conferences*, *187*, 04004. http://dx.doi.org/10.1051/e3sconf/202018704004
Manihuruk, F. M., Suryati, T., & Arief, I. I. (2017). Effectiveness of the red dragon fruit (*Hylocereus polyrhizus*) peel extract as the colorant, antioxidant, and antimicrobial on beef sausage. *Media Peternakan*, *40*(1), 47-54. http://dx.doi.org/10.5398/medpet.2017.40.1.47
May, C. D. (1990). Industrial pectins: sources, production and applications. *Carbohydrate Polymers*, *12*(1), 79-99. http://dx.doi.org/10.1016/0144-8617(90)90105-2
McClements, D. J., Das, A. K., Dhar, P., Nanda, P. K., & Chatterjee, N. (2021). Nanoemulsion-Based Technologies for Delivering Natural Plant-Based Antimicrobials in Foods [Review]. *Frontiers in Sustainable Food Systems*, *5*. http://dx.doi.org/10.3389/fsufs.2021.643208
Methacanon, P., Krongsin, J., & Gamonpilas, C. (2014). Pomelo (*Citrus maxima*) pectin: Effects of extraction parameters and its properties. *Food Hydrocolloids*, *35*, 383-391. http://dx.doi.org/10.1016/j.foodhyd.2013.06.018
Miller, S. M., Fugate, E. J., Craver, V. O., Smith, J. A., & Zimmerman, J. B. (2008). Toward understanding the efficacy and mechanism of Opuntia spp. as a natural coagulant for potential application in water treatment. *Environmental science & technology*, *42*(12), 4274-4279. http://dx.doi.org/10.1021/es7025054
Mishra, S., Sachan, A., & Sachan, S. G. (2013). Production of natural value-added compounds: an insight into the eugenol biotransformation pathway. *Journal of Industrial Microbiology and Biotechnology*, *40*(6), 545-550. http://dx.doi.org/10.1007/s10295-013-1255-9
Mizrahi, Y., Nerd, A., & Nobel, P. S. (1996). Cacti as Crops. In *Horticultural Reviews* (pp. 291-319). http://dx.doi.org/10.1002/9780470650608.ch6
Mohd Zaini, H., Roslan, J., Saallah, S., Munsu, E., Sulaiman, N. S., & Pindi, W. (2022). Banana peels as a bioactive ingredient and its potential application in the food industry. *Journal of Functional Foods*, *92*, 105054. http://dx.doi.org/10.1016/j.jff.2022.105054
Moorthy, I. G., Maran, J. P., Ilakya, S., Anitha, S., Sabarima, S. P., & Priya, B. (2017). Ultrasound assisted extraction of pectin from waste *Artocarpus heterophyllus* fruit peel. *Ultrasonics Sonochemistry*, *34*, 525-530. http://dx.doi.org/10.1016/j.ultsonch.2016.06.015
Nga, N. T., & Trang, N. T. (2015). Influence of the Fermentation of Pineapple Wastes with the Use of Methanobacterium Strains Separated in Vietnam on the Production of Biogas from them. *Journal of Engineering Physics and Thermophysics*, *88*(2), 392-397. http://dx.doi.org/10.1007/s10891-015-1204-8
Ngo, T. V., Kusumawardani, S., Kunyanee, K., & Luangsakul, N. (2022). Polyphenol-Modified Starches and Their Applications in the Food Industry: Recent Updates and Future Directions. *Foods*, *11*(21), 3384. http://dx.doi.org/10.3390/foods11213384
Nguyen, T. P., & Le, V. V. M. (2012). Application of ultrasound to pineapple mash treatment in juice processing. *International Food Research Journal*, *19*(2), 547-552.
Nguyen, T. T. H., Pham, D. C., Chu, T. P., Vu, N. H., Samhaber, W. M., & Nguyen, M. T. (2021). Impact of JEVA Evaporation on Storage Stability and Physiochemical Characteristics of Vietnam Red Dragon Fruit (Hylocereus polyrhizus). *Chemical Engineering Transaction*, *87*, 169-174. http://dx.doi.org/10.3303/CET2187029
Nguyen, T.-D., Venkatadri, U., Nguyen-Quang, T., Diallo, C., & Adams, M. (2020). Optimization Model for Fresh Fruit Supply Chains: Case-Study of Dragon Fruit in Vietnam. *AgriEngineering*, *2*(1), 1-26. http://dx.doi.org/10.3390/agriengineering2010001
Nogata, Y., Sakamoto, K., Shiratsuchi, H., Ishii, T., Yano, M., & Ohta, H. (2006). Flavonoid composition of fruit tissues of citrus species. *Bioscience, biotechnology, and biochemistry*, *70*(1), 178-192. http://dx.doi.org/10.1271/bbb.70.178
Norazreen, A. J., Norfhairna, B., Zurina, M. M., Mustapha, & Siti, H. C. M. (2018). Pineapple Leaves Fiber (PALF) Crosslinked with Chitosan for Antimicrobial Properties *Chemical Engineering Transaction*, *63*, 373-378. http://dx.doi.org/10.3303/CET1863063
Nurliyana, R., Zahir, I., Suleiman, K., Aisyah, M. R., & Kamarudin, K. R. (2010). Antioxidant study of pulps and peels of dragon fruits: A comparative study. *International Food Research Journal*, *17*, 367-375.

Nwakaire, J., Obi, F. O., & Ugwuishiwu, B. (2016). Agricultural waste concept, generation, utilization and management. *Nigerian Journal of Technology*, *35*, 957-964. http://dx.doi.org/10.4314/njt.v35i4.34
OECD. (2011). *Strategy, A Green Growth for Food and Agriculture (Organization for Economic Co-operation and Development)*. https://www.oecd.org/greengrowth/sustainable-agriculture/48224529.pdf
Oliveira, F., Souza, C. E., Peclat, V. R. O. L., Salgado, J. M., Ribeiro, B. D., Coelho, M. A. Z., Venâncio, A., & Belo, I. (2017). Optimization of lipase production by *Aspergillus ibericus* from oil cakes and its application in esterification reactions. *Food and Bioproducts Processing*, *102*, 268-277. http://dx.doi.org/10.1016/j.fbp.2017.01.007
Pereira, A., & Maraschin, M. (2015). Banana (*Musa* spp) from peel to pulp: ethnopharmacology, source of bioactive compounds and its relevance for human health. *Journal of ethnopharmacology*, *160*, 149-163. http://dx.doi.org/10.1016/j.jep.2014.11.008
Peterson, J. J., Dwyer, J. T., Beecher, G. R., Bhagwat, S. A., Gebhardt, S. E., Haytowitz, D. B., & Holden, J. M. (2006). Flavanones in oranges, tangerines (mandarins), tangors, and tangelos: a compilation and review of the data from the analytical literature. *Journal of Food Composition and Analysis*, *19*, S66-S73. http://dx.doi.org/10.1016/j.jfca.2005.12.006
Phan, T. T. M., & Ngo, T. S. (2020). Pectin and cellulose extraction from passion fruit peel waste. *Vietnam Journal of Science, Technology and Engineering*, *62*(1), 32-37. http://dx.doi.org/10.31276/VJSTE.62(1).32-37
Phan, T. T. M., Ho, V. C., & Pham, N. L. (2020). A study on synthesis and properties of SAPs based on carboxymethyl cellulose. *Vietnam Journal of Science, Technology and Engineering*, *62*(3), 26-32. http://dx.doi.org/10.31276/VJSTE.62(3).26-32
Poljsak, B., & Milisav, I. (2018). The role of antioxidants in cancer, friends or foes? *Current Pharmaceutical Design*, *24*(44), 5234-5244. http://dx.doi.org/10.2174/1381612825666190123112647
Rafiq, S., Kaul, R., Sofi, S. A., Bashir, N., Nazir, F., & Ahmad Nayik, G. (2018). Citrus peel as a source of functional ingredient: A review. *Journal of the Saudi Society of Agricultural Sciences*, *17*(4), 351-358. http://dx.doi.org/10.1016/j.jssas.2016.07.006
Rahman, M., Hossain, T. B., Hossain, M. S., Sattar, S., & Das, P. C. (2019). Effect of banana peel extract on storage stability of banana cv. Sagar. *Food Research*, *4*(2), 488-494. http://dx.doi.org/10.26656/fr.2017.4(2).323
Rattanathanalerk, M., Chiewchan, N., & Srichumpoung, W. (2005). Effect of thermal processing on the quality loss of pineapple juice. *Journal of Food Engineering*, *66*(2), 259-265. http://dx.doi.org/10.1016/j.jfoodeng.2004.03.016
Rebecca, O., Nasrulhaq Boyce, A., & Somasundram, C. (2010). Pigment identification and antioxidant properties of red dragon fruit (*Hylocereus polyrhizus*). *African Journal of Biotechnology*, *9*, 1450-1454. http://dx.doi.org/10.5897/AJB09.1603
Reboredo-Rodríguez, P., Varela-López, A., Forbes-Hernández, T. Y., Gasparrini, M., Afrin, S., Cianciosi, D., Zhang, J., Manna, P. P., Bompadre, S., & Quiles, J. L. (2018). Phenolic compounds isolated from olive oil as nutraceutical tools for the prevention and management of cancer and cardiovascular diseases. *International Journal of Molecular Sciences*, *19*(8), 2305. http://dx.doi.org/10.3390/ijms19082305
Rengsutthi, K., & Charoenrein, S. (2011). Physico-chemical properties of jackfruit seed starch (*Artocarpus heterophyllus*) and its application as a thickener and stabilizer in chilli sauce. *LWT-Food Science and Technology*, *44*(5), 1309-1313. http://dx.doi.org/10.1016/j.lwt.2010.12.019
Rodriguez, E., Vidallon, M., Mendoza, D., Dalisay, K., & Reyes, C. (2015). Stabilization of Betalains from the Peel of Red Dragon Fruit [*Hylocereus polyrhizus* (Weber) Britton & Rose] through Biopolymeric Encapsulation. *The Philippine agriculturist*, *98*, 382-391.
Sagar, N. A., Pareek, S., Sharma, S., Yahia, E. M., & Lobo, M. G. (2018). Fruit and Vegetable Waste: Bioactive Compounds, Their Extraction, and Possible Utilization. *Comprehensive reviews in food science and food safety*, *17*(3), 512-531. http://dx.doi.org/10.1111/1541-4337.12330
Saharan, P., Kumar, P., & Duhan, J. (2017). Comparative assessment of effect of fermentation on phenolics, flavanoids and free radical scavenging activity of commonly used cereals. *Biocatalysis and Agricultural Biotechnology*, *12*, 236-240. http://dx.doi.org/10.1016/j.bcab.2017.10.013
Sajilata, M. G., Singhal, R. S., & Kulkarni, P. R. (2006). Resistant Starch–A Review. *Comprehensive reviews in food science and food safety*, *5*(1), 1-17. http://dx.doi.org/10.1111/j.1541-4337.2006.tb00076.x
Santiago, B., Moreira, M. T., Feijoo, G., & González-García, S. (2020). Identification of environmental aspects of citrus waste valorization into D-limonene from a biorefinery approach. *Biomass and Bioenergy*, *143*, 105844. http://dx.doi.org/10.1016/j.biombioe.2020.105844
Sasikala, M., & Umapathy, M. J. (2018). Preparation and characterization of pineapple leaf cellulose nanocrystal reinforced gelatin bio-nanocomposite with antibacterial banana leaf extract for application in food packaging [10.1039/C8NJ02973C]. *New Journal of Chemistry*, *42*(24), 19979-19986. http://dx.doi.org/10.1039/C8NJ02973C
Sharifah, N., Nur, A., & Sarva, M. P. (2018). The used of dragon fruit peels as eco-friendly wastewater coagulants. *Asian Journal of Agriculture and Biology*, Special Issue, 66-71.
Sharma, B., Naresh, L., Dhuldhoya, N., Merchant, S., & Merchant, U. (2006). An overview on pectins. *Times Food Processing Journal*, *23*(2), 44-51.
Sibhatu, H. K., Anuradha Jabasingh, S., Yimam, A., & Ahmed, S. (2021). Ferulic acid production from brewery spent grains, an agro-industrial waste. *LWT-Food Science and Technology*, *135*, 110009. http://dx.doi.org/10.1016/j.lwt.2020.110009
Socaci, S. A., Farcas, A., Vodnar, D. C., & Tofana, M. (2017). Food wastes as valuable sources of bioactive molecules. *Superfood and Functional Food—The Development of Superfoods and Their Roles as Medicine. Rijeka, Croatia: InTech*, 75-93. http://dx.doi.org/10.5772/66115
Sofowora, A., Ogunbodede, E., & Onayade, A. (2013). The role and place of medicinal plants in the strategies for disease prevention. *African journal of traditional, complementary, and alternative medicines*, *10*(5), 210-229. http://dx.doi.org/10.4314/ajtcam.v10i5.2
Song, N. V., Ha, T. V., Thuan, T. D., Hanh, N. V., Tien, D. V., Tiep, N. C., Phuong, N. T. M., Tu, P. A., & Uan, T. B. (2021). Development of Rice Husk Power Plants Based on Clean Development Mechanism: A Case Study in Mekong River Delta, Vietnam. *Sustainability*, *13*(12), 6950. http://dx.doi.org/10.3390/su13126950
Sun, H.-Y., Li, J., Zhao, P., & Peng, M. (2011). Banana peel: A novel substrate for cellulase production under solid-state fermentation. *African Journal of Biotechnology*, *10*(77), 17887-17890. http://dx.doi.org/10.5897/AJB10.1825
Szabo, K., Dulf, F. V., Diaconeasa, Z., & Vodnar, D. C. (2019). Antimicrobial and antioxidant properties of tomato processing byproducts and their correlation with the biochemical composition. *LWT-Food Science and Technology*, *116*, 108558. http://dx.doi.org/10.1016/j.lwt.2019.108558
Tai, N. V., & Thuy, N. M. (2023). Optimization of osmotic dehydration process for quality improvement of vacuum fried "Vinh Chau" shallot at pilot scale. *Acta Scientiarum Polonorum Technologia Alimentaria*, *22*(2), In press. http://dx.doi.org/10.17306/J.AFS.1120
Tai, N. V., Linh, M. N., & Thuy, N. M. (2021a). Modeling of thin layer drying characteristics of "Xiem" banana peel cultivated at U Minh district, Ca Mau province, Vietnam. *Food Research*, *5*(5), 244-249. http://dx.doi.org/10.26656/fr.2017.5(5).180
Tai, N. V., Linh, M. N., & Thuy, N. M. (2021b). Optimization of extraction conditions of phytochemical compounds in "Xiem" banana peel powder using response surface methodology. *Journal of Applied Biology & Biotechnology*, *9*(6), 56-62. http://dx.doi.org/10.7324/JABB.2021.9607
Tao, N.-g., Liu, Y.-j., & Zhang, M.-l. (2009). Chemical composition and antimicrobial activities of essential oil from the peel of bingtang sweet orange (*Citrus sinensis* Osbeck). *International Journal of Food Science & Technology*, *44*(7), 1281-1285. http://dx.doi.org/10.1111/j.1365-2621.2009.01947.x
Thanh, N. V., Thuy, N. M., & Trang, D. T. D. (2013). Tận dụng phế phẩm khóm cầu đúc (Hậu Giang) cho quá trình trích ly enzyme bromelain. *Can Tho Unversity Journal of Science*, *26B*, 162-170.
Thien, D. V. H., Lam, D.-N., Diem, H. N., Pham, T. Y. N., Bui, N. Q., Truc, T. N. T., & Van-Pham, D.-T. (2022). Synthesis of cellulose-g-poly(acrylic acid) with high water absorbency using pineapple-leaf extracted cellulose fibers. *Carbohydrate polymers*, *288*, 119421. http://dx.doi.org/10.1016/j.carbpol.2022.119421
Thuy, N. M., & Van Tai, N. (2022). Effect of different cooking conditions on resistant starch and estimated glycemic index of macaroni. *Journal of Applied Biology and Biotechnology*, *10*(5), 151-157. http://dx.doi.org/10.7324/JABB.2022.100519
Thuy, N. M., Ben, T. C., Ngoc, P. T. B., & Van Tai, N. (2022d). Application of butterfly pea flower extract in processing some Vietnamese traditional foods. *Journal of Applied Biology and Biotechnology*, *10*(5), 143-150. http://dx.doi.org/10.7324/JABB.2022.100518
Thuy, N. M., Giau, T. N., Tien, V. Q., Van Thanh, N., & Van Tai, N. (2023b). Developing a nutritious soup product using purple sweet potatoes supplemented with composite of vegetables and freezed-dried chicken. *Food Sci. Technol*, *43*, e119922. http://dx.doi.org/10.1590/fst.119922
Thuy, N. M., Ha, H. T. N., & Tai, N. V. (2021). Optimization of carrot fermentation conditions in rice bran bed using *Lactobacillus plantarum*. *Acta Scientiarum Polonorum Technologia Alimentaria*, *20*(4), 449-457. http://dx.doi.org/10.17306/J.AFS.0944
Thuy, N. M., Han, L. N., & Tai, N. V. (2022a). Thermal stability of anthocyanin in mixed raspberry-pomegranate-banana nectar in the presence of ascorbic acid and citric acid. *Journal of Applied Biology & Biotechnology*, *10*(1), 189-195. http://dx.doi.org/10.7324/JABB.2021.100123
Thuy, N. M., Hiep, L. H., Tai, N. V., Huong, H. T. T., & Minh, V. Q. (2022g). Impact of drying temperatures on drying behaviours, energy consumption and quality of purple sweet potato flour. *Acta Scientiarum Polonorum Technologia Alimentaria*, *21*(4), 379-387. http://dx.doi.org/10.17306/J.AFS.2022.1061
Thủy, N. M., Huyền, L. T. N., Tài, N. V., Phương, N. P., Nguyên, L. T. T., Ly, N. T. T., Tuyền, N. T. M., & Cường, N. P. (2018). Tối ưu hóa các phương pháp trích ly quercetin từ vỏ hành tím [Optimization of extraction methods for quercetin

from shallot skin]. *Tạp chí Khoa học Công nghệ Nông nghiệp Việt Nam*, *12*(97), 57-61.
Thuy, N. M., My, L. T. D., Ben, T. C., & Tai, N. V. (2023a). Development and quality evaluation of healthy soup for children making from banana and other vegetables. *Asia-Pacific Journal of Science and Technology*, *28*(01), 1-10. http://dx.doi.org/10.14456/apst.2023.9
Thuy, N. M., Ngoc, P. T. B., & Tai, N. V. (2022c). Effect of conventional and ultrasonic-assisted extracts on betacyanin content of red dragon fruit (*Hylocereus polyrhizus*). *Food Research*, *6*(3), 389-395. http://dx.doi.org/10.26656/fr.2017.6(3).754
Thủy, N. M., Như, L. T. T., Nhi, H. T. C., Nhi, N. T. H., Bên, T. C., Hà, H. T. N., & Tài, N. V. (2022). Phân tích mô tả định lượng và phân tích thành phần chính đối với đặc điểm cảm quan của củ cải và dưa leo muối chua trong môi trường cám gạo. *Tạp chí Khoa học Trường Đại học Cần Thơ*, *58*(1), 132-142. http://dx.doi.org/10.22144/ctu.jvn.2022.014
Thuy, N. M., Nhu, P. H., Tai, N. V., & Minh, V. Q. (2022e). Extraction Optimization of Crocin from Gardenia (Gardenia jasminoides Ellis) Fruits Using Response Surface Methodology and Quality Evaluation of Foam-Mat Dried Powder. *Horticulturae*, *8*(12), 1199. http://dx.doi.org/10.3390/horticulturae8121199
Thuy, N. M., Phung, L. B., Tai, N. V., & Minh, V. Q. (2023c). Impact of foaming conditions on quality for foam-mat drying of Butterfly pea flower by multiple regression analysis. *Plant Science Today*, *10*(2), 51-57. http://dx.doi.org/10.14719/pst.1913
Thuy, N. M., Tien, V. Q., Van Tai, N., & Minh, V. Q. (2022f). Effect of Foaming Conditions on Foam Properties and Drying Behavior of Powder from Magenta (*Peristrophe roxburghiana*) Leaves Extracts. *Horticulturae*, *8*(6), 546. http://dx.doi.org/10.3390/horticulturae8060546
Thuy, N. M., Too, B. C., Vuong, K. M., Lan, P. T. T., Tuyen, P. T. T., Tram, N. B., & Van Tai, N. (2022b). Resistant starch in various starchy vegetables and the relationship with its physical and chemical characteristics. *Journal of Applied Biology and Biotechnology*, *10*(1), 181-188. http://dx.doi.org/10.7324/JABB.2021.100122
Thuy, N. M., Tuyen, N. T. M., Cuong, N. P., Huyen, L. T. N., Phuong, N. P., Nguyen, L. T. T., Kim, J. H., Thu, N. T., & Tai, N. V. (2020). Identification and extraction method of quercetin from flesh and skin of shallot (*Allium ascalonicum*) cultivated in Soc Trang Province, Vietnam. *Food Research*, *4*(2), 358-365. http://dx.doi.org/10.26656/fr.2017.4(2).306
Toan, T., Truc, T., Le, X., Quyen, N., & Tran, T. (2020). Study on extraction process and analysis of components in essential oils of Vietnamese orange peel (*Citrus sinensis*) by microwave assisted hydrodistillation extraction. IOP Conference Series: Materials Science and Engineering, 991,012125. http://dx.doi.org/10.1088/1757-899X/991/1/012125
Tran, N. G., Nguyen, M. T., Vo, Q. T., & Ngo, V. T. (2023). Quality evaluation of waffles produced from the partial replacement of wheat flour with green banana flour and potato starch. *Acta Scientiarum Polonorum Technologia Alimentaria*, *22*(1), 13-21. http://dx.doi.org/10.17306/J.AFS.2023.1076
Tran, P. L., Nguyen, D. H. D., Do, V. H., Kim, Y.-L., Park, S., Yoo, S.-H., Lee, S., & Kim, Y.-R. (2015). Physicochemical properties of native and partially gelatinized high-amylose jackfruit (*Artocarpus heterophyllus* Lam.) seed starch. *LWT-Food Science and Technology*, *62*(2), 1091-1098. http://dx.doi.org/10.1016/j.lwt.2015.01.054
Tran, Q., Pham, Q., Pham, Q., Thi Kim Ngan, T., Pham, H. H., Luu, V., & Than, V. (2020). Evaluation of chemical composition in essential oils from *Schefflera octophylla* L. Hai Duong province in Vietnam. *IOP Conference Series: Materials Science and Engineering*, *991*, 012128. http://dx.doi.org/10.1088/1757-899X/991/1/012128
Tran, T. H., Nguyen, P. T. N., Ho, V. T. T., Le, T. H. N., Bach, L. G., & Nguyen, T. D. (2019). Using soft computing approaches for orange (*Citrus nobilis Lour. var. nobilis*) oils extraction process. IOP Conference Series: Materials Science and Engineering, 479, 0120015. http://dx.doi.org/10.1088/1757-899X/479/1/012015
Trang, H. T. H., & Pasuwan, P. (2018). Screening antimicrobial activity against pathogens from protein hydrolysate of rice bran and Nile Tilapia by-products. *International Food Research Journal*, *25*(5), 2157-2163.
Trang, N. T., Xuan, L. T. T., Nga, N. T., Sang, L. Q., & Duy, P. V. (2013). Researching for use microogranism strains for decompose of organic argicultural waste to generate of biogas. 3rd International Science Conference on Sustainable Energy Development, Ha Noi, Vietnam.
Tripathi, S., Narayan, S., & Sharma, S. (2013). Emissions from Crop/Biomass Residue Burning Risk to Atmospheric Quality. *International Research Journal of Earth Sciences*, *1*(1), 1-5.
Truong, H. T., Do Van, M., Duc Huynh, L., Thi Nguyen, L., Do Tuan, A., Le Xuan Thanh, T., Duong Phuoc, H., Takenaka, N., Imamura, K., & Maeda, Y. (2017). A method for ferulic acid production from rice bran oil soapstock using a homogenous system. *Applied sciences*, *7*(8), 796. http://dx.doi.org/10.3390/app7080796
Tulyathan, V., Tananuwong, K., Songjinda, P., & Jaiboon, N. (2002). Some physicochemical properties of jackfruit (*Artocarpus heterophyllus* Lam) seed flour and starch. *Science Asia*, *28*(1), 37-41. http://dx.doi.org/10.2306/scienceasia1513-1874.2002.28.037
Tuyet Phan, M. T., Pham, L. N., Nguyen, L. H., & To, L. P. (2021). Investigation on Synthesis of Hydrogel Starting from Vietnamese Pineapple Leaf Waste-Derived Carboxymethylcellulose. *Journal of Analytical Methods in Chemistry*, *2021*, 6639964. http://dx.doi.org/10.1155/2021/6639964
Van Hung, P., Anh, M. N. T., Hoa, P. N., & Phi, N. T. L. (2021). Extraction and characterization of high methoxyl pectin from *Citrus maxima* peels using different organic acids. *Journal of Food Measurement and Characterization*, *15*(2), 1541-1546. http://dx.doi.org/10.1007/s11694-020-00748-y
Van Hung, P., Yen Nhi, N. H., Ting, L. Y., & Lan Phi, N. T. (2020). Chemical Composition and Biological Activities of Extracts from Pomelo Peel By-Products under Enzyme and Ultrasound-Assisted Extractions. *Journal of Chemistry*, *2020*, 1043251. http://dx.doi.org/10.1155/2020/1043251
Van Loi, N., & Uyen, N. Q. (2016). Primary study on the components and main physicochemical as well as biological properties of the oil of *Alpinia galanga* (L.) Wild in Phu Tho-Vietnam. *African Journal of Biotechnology*, *15*(48), 2739-2742. http://dx.doi.org/10.5897/AJB2016.15525
Van Tuan, N., Cam, Q. N. T., & Cang, M. H. (2021). Research methods of refined oil from peel calamondin (C*itrus microcarpa*) from Tien Giang Province, Vietnam. E3S Web of Conferences,
Vu, H. T., Scarlett, C. J., & Vuong, Q. V. (2018). Phenolic compounds within banana peel and their potential uses: A review. *Journal of Functional Foods*, *40*, 238-248. http://dx.doi.org/10.1016/j.jff.2017.11.006
Vu, P. V., Doan, T. D., Tu, G. C., Do, N. H. N., Le, K. A., & Le, P. K. (2022). A novel application of cellulose aerogel composites from pineapple leaf fibers and cotton waste: Removal of dyes and oil in wastewater. *Journal of Porous Materials*, 1137-1147. http://dx.doi.org/10.1007/s10934-022-01238-w
Wu, M.-Y., & Shiau, S.-Y. (2015). Effect of the Amount and Particle Size of Pineapple Peel Fiber on Dough Rheology and Steamed Bread Quality. *Journal of Food Processing and Preservation*, *39*(6), 549-558. http://dx.doi.org/10.1111/jfpp.12260
Xiao Nan, Y., & Sun Chul, K. (2013). Chemical composition, antioxidant and antibacterial activities of essential oil from Korean *Citrus unshiu* peel. *Journal of Agricultural chemistry and Environment*, *2013*, 42-49.
Xu, S.-Y., Liu, J.-P., Huang, X., Du, L.-P., Shi, F.-L., Dong, R., Huang, X.-T., Zheng, K., Liu, Y., & Cheong, K.-L. (2018). Ultrasonic-microwave assisted extraction, characterization and biological activity of pectin from jackfruit peel. *LWT*, *90*, 577-582. http://dx.doi.org/10.1016/j.lwt.2018.01.007
Xuan Sam, N. T., & Huyen, L. T. (2018). Extraction of pectin from passion fruit peel for production of pectic oligosaccharides (POS). *Vietnam Journal of Science and Technology*, *55*(5A), 195-201. http://dx.doi.org/10.15625/2525-2518/55/5A/12195
Yi, L., Ma, S., & Ren, D. (2017). Phytochemistry and bioactivity of Citrus flavonoids: a focus on antioxidant, anti-inflammatory, anticancer and cardiovascular protection activities. *Phytochemistry Reviews*, *16*(3), 479-511. http://dx.doi.org/10.1007/s11101-017-9497-1
Yin, J.-S., Liang, Q.-L., Li, D.-M., & Sun, Z.-T. (2013). Optimization of production conditions for β-mannanase using apple pomace as raw material in solid-state fermentation. *Annals of Microbiology*, *63*(1), 101-108. http://dx.doi.org/10.1007/s13213-012-0449-0
Zarina, Z., & Tan, S. (2013). Determination of flavonoids in *Citrus grandis* (Pomelo) peels and their inhibition activity on lipid peroxidation in fish tissue. *International Food Research Journal*, *20*(1), 313-317.
Zou, Z., Xi, W., Hu, Y., Nie, C., & Zhou, Z. (2016). Antioxidant activity of Citrus fruits. *Food chemistry*, *196*, 885-896. http://dx.doi.org/10.1016/j.foodchem.2015.09.072