International Journal Scientific and Profesional (IJ-ChiProf)
Vol.1 Issue.1 February 2022, pp: 1-9
ISSN: 2829-2618 (Online)

Identification Of Nutritional Content, Taxonomy and Processed Products Of Campolay Fruit (*Pouteria Champeciana*)

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Article Info

Article history:
Received Jan 9, 2022
Revised Jan 20, 2022
Accepted Feb 11, 2022

Keywords:
Vitamin C
Total Carotene Content
Total Sugar Content
Mineral
Campolay Fruit
Processed Products

ABSTRACT

Pouteria champeciana (campolay) is a type of tropical fruit grown in Indonesia. Though the nutritional content of the fruit has the potential as a processed food product. This study analyzed taxonomy, vitamin C, total carotene, total sugar content and minerals (Ca, Mg, K, Na) in campolay fruit and processing campolay fruit flesh into processed food products. This type of research is descriptive research. Campolay fruit obtained from Tarogong Kidul, Garut Regency, West Java. Analysis of vitamin C levels in campolay fruit flesh using the iodometric titration method, total carotene using spectrophotometric methods, testing total sugar content using the Nelson Somogyi method and mineral testing (Ca, Mg, K, Na) on campolay fruit using AAS. The results of the analysis showed that the level of vitamin C in the campolay fruit flesh was 215.685 (mg/100g), total carotene of 31.185 (mg/100g), total sugar content 18.085% and minerals (Ca, Mg, Na, K) on a campolay fruit of 1124.481 (ppm), 358.914 (ppm), 431.996 (ppm) and 8183.999 (ppm). Campolay fruit processing can be used in a variety of food products such as smoothies, cup cakes, cereal flakes, puddings and jelly drinks.

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1. INTRODUCTION

Campolay fruit (Pouteria campechiana) is an oval-shaped tropical fruit with dense flesh and dark yellow color (Pushpakumara, 2007). The color of this campolay fruit is known to come from the carotenoid type group xanthophylls (Murillo et al., 2010). Based on a literature study, the nutrient content of carbohydrates is 36.7-39.1 gr with an energy value of 580-630 kj/100 g (Verheij & Coronel 1997). When compared with other types of fruit in the Sapotaceae family, campolay fruit contains carbohydrates, carotene and also niacin which is higher than in its family (Anjo, 2021). In addition, it is known that campolay fruit contains polyphenols which can act as having strong antioxidants and have a significant hepatoprotective effect on hepatotoxicity in rats (Aseervatham et al., 2014).

Vitamins as components of important nutrients are antioxidants and have immunomodulatory effects (Shakoor et al. 2020). When the body is deficient in vitamins and minerals in plasma concentrations it can affect the immune system. Vitamin C is known to act as a powerful antioxidant in fighting free radical species (Gombart et al. 2020). Vitamin C is well known for its antiviral properties by increasing interferon-alpha production, modulating cytokines, reducing inflammation, correcting endothelial dysfunction, and restoring mitochondrial function (Carr & Maggini 2017). Vitamin C helps and supports the immune system in the body by helping to remove dead cells and replace them with new cells (Ekert & Vaux 1997; Carr & Maggini 2017).

Many epidemiological studies have shown that low intake of essential minerals plays an important role in the prevention of cardiovascular and cerebrovascular diseases, and may be involved in the development of corona infection (Zabtakis et al. 2020). Calcium as a macro mineral needed by the body plays an important role in making our bones stronger, but also works against invading viruses by removing it from cells (Rodriguez-Morales et al.

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ISSN: 2829-2618 (Online)

2020). Sodium plays an important role in the regulation of electrolyte balance and ACE2 expression in SARS-CoV-2 (Luo et al. 2020). Lack of potassium in the body (hypokalemia) can increase ARDS and the risk of acute heart injury, which is considered the most common complication in COVID-19. The literature shows that SARS-CoV-2 bond ACE2 and reduced his expression. As a result, angiotensin-II increases, which then causes hypokalemia (Alwaqfi & Ibrahim 2020). Magnesium plays an important role in immune function by regulating various functions such as immune cell adherence, immunoglobulin synthesis, lymphocyte binding Immunoglobulin M (IgM), antibody- dependent cytolysis (Ni et al. 2020).

Coronavirus is the cause of a newly discovered infectious disease known as COVID-19 and declared a global pandemic. Vitamins and minerals can play an important function in strengthening the immune system and reducing infections (Kumar et al. 2021). However, the reasons behind decreased immunity are inflammation, improper functioning of T cells, due to dietary imbalance, lack of micro and macro nutrients (Derbyshire & Delange 2020). According to Derbyshire & Delange (2020) that there are two important steps in the fight against COVID-19 infection are proper nutritional intake and activation of the immune system to fight disease.

The nutritional value of campolay fruit, especially vitamin C and several types of macro minerals (Ca, Mg, Na, K) researched and suspected to have potential as a nutritious food product. Information about the content and utilization is still limited and the lack of public interest makes researchers interested in analyzing the nutritional content and processing it as a food product from campolay fruit. At this time during the pandemic, children have started going to school and are actively learning. One of the steps to maintain immunity in a child's body is to pay attention to the balance of nutrient intake. Nutrients as an important component derived from daily food. The food that needs to be consumed by them is a balanced diet based on the quantity and quality of nutrients. Manggini et al. (2018), if the intake of vitamins and minerals is sufficient, the immunity of the child's body will be more awake. School-age children need to innovate their favorite food products. So that the processing of campolay fruit flesh can be consumed and utilized. The purpose of this study was to analyze the levels of vitamin C, total carotene, total sugar content and macro minerals (Ca, Mg, Na and K), taxonomy of campolay fruit and knowing its processing potential in food products for school-age children during the pandemic.

2. RESEARCH METHOD

Explaining research chronological, including research design, research procedure (in the form of algorithms, Pseudocode or other), how to test and data acquisition [1-3]. The description of the course of research should be supported references, so the explanation can be accepted scientifically [2, 4].

Tables and Figures are presented center, as shown in Table 1 and Figure 1, and cited in the manuscript before appeared.

The research was conducted in August-December 2021. The research stages included taxonomic identification of campolay fruit at the Biology Laboratory of Gajah Mada University Yogyakarta, analysis of total sugar content, vitamin C content, total carotene and macro minerals (Ca, Mg, Na and K) carried out at the Gajah Mada University Chemistry Laboratory and product formulations are carried out at the Culinary Laboratory of the Bogor Agricultural University. Analysis of vitamin C levels in campolay fruit flesh using the iodine titration method, total carotene using the K method spectroscopic method. Gambang, testing for total sugar content using the Nelson somogyi method and mineral testing (Ca, Mg, K, Na) on campolay fruit using AAS.

The main ingredient used for this research is campolay fruit (Pouteria campheciana) obtained from Garut Regency, West Java. The chemicals used were beakers, 250 ml erlenmeyer, funnel, burette and stative, 10 ml measuring pipette, red proppipet, 100 ml volumetric flask, green propipeter, scales, water bath, Atomic Absorption Spectrophotometer (AAS) brand Shimadzu type AA 7000. The tools used for product formulation are stainless knife, bucket, juicer, pot stainless stell, spoon, cutting board, stirrer, stove, thermometer. The material used in this research is starch 1%, solution iod 0,01 N, and aquadest, reagent Cu alkalis, NaOH 1N, H3, H2SO4, HCl and HNO3.

This research is a type of qualitative research with descriptive method, where the research data is in the form of analysis of plant taxonomic identification, analysis of nutrient content and processing methods of food products. The selection of the location for purchasing campolay fruit is based on the availability of samples and affordable access in Tarogong Kidul sub-district, Garut district, West Java province, Indonesia. Sources of data collected in this study is primary data. Identification of plants on characteristics such as tree morphology, leaves, flowers and fruit. The identification data obtained data regarding the characteristics of campolay accompanied by documentation. Taxonomy data is assisted by existing data based on web links https://floramalesiana.org/new/links/.

The procedure of this research includes analysis of taxonomic identification of campolay fruit plants, nutritional content in the form of vitamin C, total carotene and total sugar and mineral content as well as product formulation.

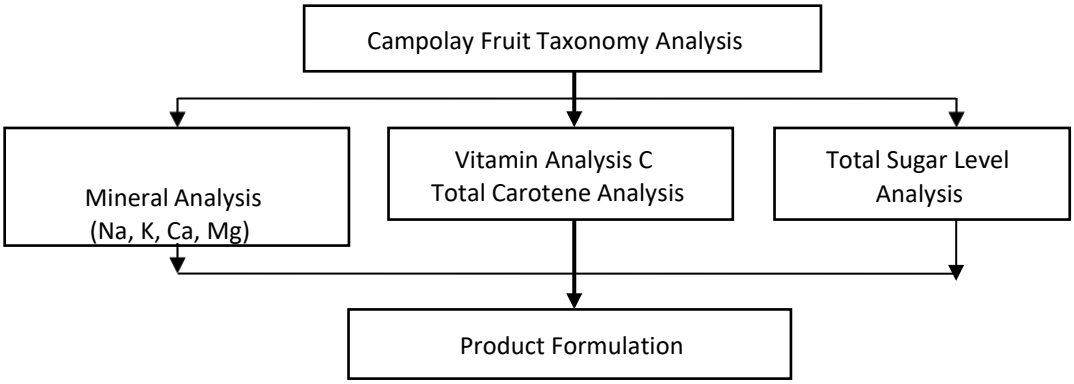

Figure 1 Research flow chart

Research data processing includes entry, editing, and cleaning. After the data is entered (entry) and checked (editing). Then the researcher re-checked (cleaning) to ensure that there are no errors in entering data. Research data will be processed using a computer program Microsoft Excel 2013.

3. RESULTS AND ANALYSIS

3.1 Campolay Fruit Taxonomy

Campolay (Pouteria campechiana) is a type of evergreen plant in the genus Pouteria, in the subfamily Chrysophylloideae in the family Sapotaceae of the order Ericales. This campolay fruit plant comes from southern Mexico and Central America. However, it has been cultivated in countries such as Taiwan, Vietnam, Brazil, the Philippines and one of them is in Indonesia (Orwa 2009). There are many types of names for this campolay fruit in Indonesia, such as alkesah, campolay, campoleh or sapodilla butter fruit.

Figure 2 Campolay fruit and leaf and stem morphology

Kingdom : Plantae
Divisio1 : Tracheophytes
Clasis : Angiosperms
Ordo : Ericales
Familia : Sapotaceae
Genus : Pouteria
Species : *P. campechiana* (Knuth)
Binomial Name : *Pouteria campechiana Baehni*
Sinonim : Lucuma campechiana Knuth,
: Lucuma nervosa A. DC
: Lucuma salicifolia Knuth

The terms or names of campolay fruit plants currently accepted are Canistel, egg fruit, yellow sapote (English), Zapote, mamey, sapodilla, amarillo (Spain), Lawalu, lavulu (Sri Lanka), egg yolk fruit, butter fruit, sapodilla butter (Malay), Olive (East Africa). Central American distribution; Bahamas, Belize, El Salvador, Guatemala, Southern Mexico (original). Nicaragua, Costa Rica, Panama, Puerto Rico, Jamaica, and Cuba, Africa: North America; Florida, South America; Africa; Kenya, Tanzania, Uganda, Middle East; Egypt, South Asia; India, Sri Lanka, Southeast Asia; Cambodia, Indonesia, Malaysia, Thailand and the Philippines (kultivar) (Awang-kanah & Abu Bakar 2018)

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ISSN: 2829-2618 (Online)

3.2 Results of Analysis of Total Sugar Levels, Vitamin C Levels, Total Carotene and Minerals (Ca, Mg, Na and K) in Campolay Fruit

Fruits contain macro and micro nutrients that are important for a balanced diet and are the main drivers in achieving nutritional security (Adiyaman et al. 2016). Many underutilized plants can provide a good source of nutrients (Ashraf et al. 2018). Campolay fruit is a type of tropical fruit originating from the family Sapotaceae which is round like an egg with a yellow color that grows in tropical and subtropical climates with various soil conditions and moderate rainfall. (Lim 2013).

Table 1. The results of the analysis of Total Sugar Levels, Vitamin C Levels,Total Carotene and Minerals (Ca, Mg, Na and K) in Campolay Fruit

Nutrient content	Repeat 1	Repeat 2	Repeat 3	Rata-rata
Vitamin C (mg/100 g)	212.93	218.44	-	215.68
Total Carotenoids (mg/100g)	30.92	31.45	-	31.18
Total Sugar (%)	18.05	18.12	-	18.08
Ca (ppm)	1117.92	1124.48	1131.03	1124.48
Mg (ppm)	362.01	355.04	359.68	358.91
Na (ppm)	434.55	429.437	431.99	431.99
K (ppm)	8080.12	8274.88	8196.98	8183.99

The results of the total carotene test on the Campolay fruit flesh were on average 31.18 (mg/100g). Carotenoids contribute to the yellow color of fruit (Anjo et al. 2021). Campolay fruit is rich in carotenoids from the xanthophylls group, serving violaxanthin, neoxanthin, zeaxanthin, cryptoxanthin and other carotenoids. (Murillo et al., 2010). Total carotene is more influenced by the color of the fruit flesh. Fruit flesh that is orange (orange) has a higher content than fruit that has green flesh color (Fukino et al., 2004). This is because carotenoids are fat-soluble pigments that are yellow to red in color. These carotenoid pigments are found in absorbance with λ = 450 nm (Kimura et al. 2007).

The results of the vitamin C test on campolay fruit flesh on average are 215.68 (mg/100g). The content of vitamin C in campolay fruit is higher when compared to the content of vitamin C in Berastagi oranges and tangerines, respectively 13.21 mg/100 gram and 12,33 mg/100 grams (Fitriana and Fitri 2020). Vitamin C is a substance that acts as an antioxidant and is effective in overcoming free radicals that can damage cells or tissues (Karinda et al, 2013). Vitamin C is a strong antioxidant, because it can donate hydrogen atoms and form relatively stable ascorbyl free radicals. This is because humans do not have the enzyme L-gulolactone oxidase (Lobo et al. 2010).

The results of the analysis of macro (K, Na, Mg) and micro (Ca) minerals in campolay fruit obtained by the Atomic Absorption Spectrophotometry method are presented in Table 1. Potassium as a mineral with the highest concentration in campolay fruit flesh compared to other test minerals. The results of the analysis of the mineral content of potassium, calcium, sodium, and magnesium in campolay meat, respectively, are: 8183.99 ppm, 1124.48 ppm, 431.99 ppm and 358.91 ppm. Mineral needs as one of the components that are needed by living things to build bone tissue, regulate osmotic pressure in the body, provide electrolytes for the needs of muscles and nerves, and make various enzymes (Berdasarkan Kemenkes (2019), that the adequacy of vitamins and minerals in children aged 7-9 years for vitamin C is 45 mg, vitamin A is 500 RE, calcium is 1000 mg, magnesium is 135 mg, potassium is 3200 mg and sodium is 100 mg. So that the content of campolay fruit can help to meet the needs of the adequacy of vitamins and minerals in children in a day. This is because the body cannot synthesize micronutrients, therefore it is necessary to have adequate intake from outside from food. If the supply of micronutrients is not sufficient, deficiency may occur and this can lead to various diseases (Wintergerst et al. 2007).

The results of the analysis of the total sugar in the campolay fruit flesh on average that is equal to 18.08%. According to Niagara et al. 2018 the total sugar content of each fruit has differences when picked and will be tested by decreasing and increasing which can be caused by several factors. Campolay fruit is a fruit that belongs to the type of climacteric fruit (Yahia 2004). Climacteric is maturity does not need to wait for maturity on the tree, however, to maintain quality, the fruit must be picked at a sufficient level of maturity. (Antarlina, 2009). Menurut Nurjanah (2002) Ethylene production in climacteric fruit tends to be influenced by environmental changes. Total

acid is related to the total sugar content, if the sugar content increases then the acid content decreases and vice versa. This is in accordance with Antarlina (2009), which states that ripe fruit has a higher sugar content than young (unripe) fruit (Yadav & Singh 2014) fruit that has just been picked and is too young, the carbohydrate content in the form of simple sugars increases, while the enzymes contained in the fruit such as catalase and amylase are not yet actively working in converting these simple sugars into vitamin C.

3.3 Campolay Fruit Formulation and Its Potential as a Nutritious Processed Food Product for Children

Fruits contain macro and micro nutrients that are important for a balanced diet and are the main drivers in achieving nutritional security (Adiyaman et al. 2016). Many underutilized plants can provide a good source of nutrients (Ashraf et al. 2018). Campolay fruit is a type of tropical fruit originating from the family Sapotaceae which is round like an egg with a yellow color that grows in tropical and subtropical climates with various soil conditions and moderate rainfall. (Lim 2013).

a. Smoothies Campolay

Smoothies are drinks that are often consumed by the public, often made using a combination of carbohydrate sources (de Graaf 2006). Menurut Hyson (2005 Many people, especially those who consume smoothies regularly, believe that by consuming regularly the health benefits can be felt. Regular consumption of energy-dense smoothies can also increase an individual's energy intake and provide the health benefits of the smoothie's nutritional content. This study uses campolay pulp to be processed into smoothies because of the nature of campolay which is included in the fruit group, has a fresh taste and is high in carbohydrates.

Figure 3 Campolay Fruit Smoothies
Source: Research Documentation

Campolay smoothies are smoothies that use ingredients from campolay fruit flesh. The use of fruit in smoothies is in line with research McCartney et al. (2018) that the energy-producing ingredients commonly used in making smoothies are fruit (90%) followed by yogurt (48%), milk (42%). Campolay smoothies have a thick and light texture, suitable for school-age children. This is in addition to the preferred texture, there is a nutrient content in the form of vitamin A which is good for children's eye health. Campolay is known to have a total carotene content of 31.18 (mg/100g) which can help meet the adequacy of vitamin A. The adequacy rate of vitamin A for school-age children aged 7-9 years is 500 (RE), in adolescent boys and girls aged 10-15 years is 600 (RE).

b. Cup Cake Campolay

Cup Cake as the trendiest, delicious and popular snack among the public, especially children. Cup cake is practically consumed anywhere and on certain occasions (Tabaldo-Tucar 2017). According to Shaikh dam Gadhe (2020). Cup cakes are most often enjoyed by school children, who need more protein than adults.

Figure 4 Campolay Fruit Flour Cupcake
Source: Research Documentation

Cup cake made using campolay meat that has been processed into flour first. Processing campolay meat into flour changes the nature of the campolay flesh itself. Especially from a bright orange color to a brick red color. However, in the manufacture of cupcakes because most of the mixture is made of flour, the color of the cupcakes does not darken Stevenson (2003) Cupcakes can generally be mixed with organic ingredients such as real fruits, seeds, nuts, spices and tubers. This is because the use of ingredients from fruits, vegetables, nuts, and seeds provides

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ISSN: 2829-2618 (Online)

optimal benefits. The addition of vegetable protein, potassium, magnesium, vitamin C, phosphate, and the antioxidant and anti-inflammatory bioactive components possessed by these ingredients provide added value to the cupcakes (Kadkhoda et al. 2020).

c. Campolay Pudding

Pudding is a type of dessert that has a sweet taste and soft texture. Generally, pudding is made from ingredients that are boiled, steamed, or baked. But there is a type of pudding that is not made from gelatin, namely from eggs and a mixture of starch flour. Pudding with raw ingredients of milk (yogurt), cornstarch, tapioca, or eggs is served after cooling it first (Oshima et al. 2014).

Figure 5 Campolay Fruit Flesh Pudding Source: Research Documentation

Campolay pudding comes from the flesh of the campolay fruit which is softened using a juicer. The nature of the campolay fruit has a soft texture, has a sweet and fresh taste and an attractive orange color. This makes the campolay pudding popular with children. Attractive and striking colors are the main attraction. According to Jayawardena-Tomas & Costel (2006) The color and texture of vanilla pudding can be attractive because consumers like puddings with attractive colors, consistency, smoothness, and a striking milk taste. (Elmore et al. 1999).

d. Jelly drink

Gelly drink (jelly drink) is a beverage product made with the main ingredient in the form of hydrocolloid. Jelly drink uses carrageenan material with a softer and softer texture (Ramanaboina et al. 2020). In addition to carrageenan, fruit juice components are one of the components in making jelly drinks. The fruit used is fruit that contains pectin. according to Agustin and Putri (2014) One of the advantages of a jelly drink is that it is not just a drink, but at the same time it can be used to delay hunger. This is because jelly drinks have a basic composition of granulated sugar which can easily be metabolized by the body to produce energy.

Figure 6 Jelly drink Campolay Fruit Juice
Source: Research Documentation

This study used fruit juice from campolay fruit. Campolay fruit has a texture like butter or cream with a sweet taste that is suitable as a component in jelly drinks. according to Noer (2007) A good jelly drink is that it has a chewy texture, is transparent, and has an original fruity aroma and taste. The gel formation in the campolay fruit jelly drink is equipped with other jelly drink components, such as carrageenan. Campolay fruit used in this study came from campolay which has a high level of physiological and morphological maturity. This is due to produce a lot of pectin and get enough taste (aroma and taste). As according to Koswara (2009) It is advisable to use physiologically ripe fruit and morphologically ripe fruit in the same ratio to produce the right pectin composition and good taste.

e. Cereal Flakes

Cereal flakes are an alternative food and are gaining popularity in Indonesian society. Cereal flakes are used as a breakfast menu as a substitute for basic carbohydrate intake like rice (Sukasih and Setyadjit 2012). Generally, cereal flakes are liked by many children because it tastes sweet and delicious when mixed with milk or yogurt. Cereal flakes are popular because of their practical processing and can be stored for a long time (Ariani et al. 2020). The main ingredients that are often used in the manufacture of breakfast cereals are corn, wheat, oats, rice, and barley.

Figure 7 Sereal Flakes Tepung Buah Campolay
Source: Research Documentation

Cereal flakes can be made using campolay fruit flour. This campolay fruit flour flakes cereal has a golden brown color. The combination of a mixture of milk or yogurt can increase the nutritional content of the flakes cereal. According to Rai and Chauhan (2008), sereal flakes using mango fruit by 49%, 23% wheat flour and 28% added sugar preferred by consumers. Fruit-based flakes are a growing industry and have competed in the breakfast cereal market in developing countries. The existence of flakes cereal products can help children love breakfast (Ermi Sukasih & Setyadjit. 2012). Various studies reveal that the role of breakfast has an impact on student achievement in school (Yao et al. 2019).

4. CONCLUSION

The results of the identification of the campolay fruit plant are included in the Sapotaceae family with the binomial name Pouteria campechiana Baehni. Vitamin and mineral levels in campolay fruit flesh are each of vitamin C 215.685 (mg/100g), total carotene of 31.185 (mg/100g), kadar gula total (%) sebesar 18.085 and mineral (Ca, Mg, Na, K) of campolay 1124.481 (ppm), 358.914 (ppm), 431.996 (ppm) and 8183.999 (ppm). Campolay fruit processing can be used in a variety of food products such as: smoothies, cup cakes, cereal flakes, puddings and jelly drinks.

ACKNOWLEDGEMENTS (10 PT)

Our thanks to all parties involved who have supported the implementation of this research.

REFERENCES

[1] Adiyaman P, Kanchana S, Usharani T, Ilaiyaraja N, Kalaiselvan A, Anila Kumar KR. 2016. Identification and quantification of polyphenolic compounds in underutilized fruits (star fruits and egg fruit) using HPLC. Indian Journal of Traditional Knowledge. 15(3):487-493.
[2] Agustin F & Putri WDR. 2014. Pembuatan jelly drink averrhoa blimbi l. (kajian proporsi belimbing wuluh : air dan konsentrasi karagenan). Jurnal Pangan dan Agroindustri. 2(3): 1-9.
[3] Alwaqfi NR dan Ibrahim KS. 2020. COVID-19: an update and cardiac involvement. J Cardiothorac Surg. 15(1):1–6. doi: 10.1186/s13019-020-01299-5
[4] Anjo. 2021. Phytochemical and technological characterization of canistel dehydrated pulp: a new potential food ingredient. Research, Society and Development, v. 10, n. 1, e16410111577. Doi: http://dx.doi.org/10.33448/rsd-v10i1.11577.
[5] Antarlina SS. 2009. Identifikasi Sifat Fisik dan Kimia Buah-buahan Lokal Kalimantan. Buletin Plasma Nutfah.
[6] 15(2): 80-90.
[7]
[8] Ariani RNP, Rahmi A, Nugroho A. 2020. Karakteristik kimia, mikrobiologi, sensori sereal flakes berbahan dasar tepung ubi nagara. JTAI Politala. 7(1):1-11.
[9] Aseervatham GSB, Sivasudha T, Sasikumar JM, Christabel PH, Jeyadevi R, Ananth DA. 2014. Antioxidant and hepatoprotective potential of Pouteria campechiana on acetaminophen-induced hepatic toxicity in rats. Journal of Physiology and Biochemistry. 70(1): 1–14. https://doi.org/10.1007/s13105- 013-0274-3.
[10] Ashraf MY, Ashraf M, Ozturk M. 2018. Underutilized Vegetables: A Tool to Address Nutritional Issues, Poverty Reduction and Food Security (Eds.), Global Perspectives on Underutilized Crops Springer, Cham. Doi: 10.1007/978-3-319-77776-4_1
[11] Awang-Kanak F, Bakar MFA. Canistel - Pouteria campechiana (Kunth) Baehni. In: Exotic Fruit Reference Guide. Elsevier Inc, 2018. Doi:10.1016/B978-0-12-803138-4.00015-0
[12] Canistel—Pouteria campechiana (Kunth) Baehni. Exotic Fruits Reference Guide.107-111 DOI: http://dx.doi.org/10.1016/B978-0-12-803138-4.00015-0
[13] Carr AC. 2020. A new clinical trial to test high-dose vitamin C in patients with COVID- 19. Crit Care. Crit Care. 2020. 24(1):1–2. doi: 10.1186/s13054-020-02851-4

[14] De Graaf C. 2006. Effects of Snacks on Energy Intake: An Evolutionary Perspective. Appetite. 47(1):18-23.
[15] Derbyshire E, Delange J. 2020. COVID-19: is there a role for immunonutrition, particularly in the over 65s? BMJ Nutrition, Prevention & Health. 3(1):100–105. doi: 10.1136/bmjnph-2020-000071.
[16] Ekert PG dan Vaux DL. Apoptosis and the immune system. Br Med Bull. 1997;53(3):591–603. doi: 10.1093/oxfordjournals.bmb.a011632.
[17] Elmore JR, Heymann H, Johnson J, Hewett JE. 1999. Preference mapping: Relating acceptance of 'creaminess' to a descriptive sensory map of a semi-solid. Food Quality and Preference. 10:465–475.
[18] Ermi Sukasih dan Setyadjit. 2012. Formulasi pembuatan flake berbasis talas untuk makanan sarapan (breakfast meal) energi tinggi dengan metode oven. J. Pascapanen. 9(2): 70-76.
[19] Fadzilah Awang-Kanak1,2 and Mohd Fadzelly Abu Bakar1
[20] Fitriana YAN dan Fitri AS. 2020. Analisis Kadar Vitamin C pada Buah Jeruk Menggunakan Metode Titrasi Iodometri. Sainteks 17(1):27. DOI:10.30595/sainteks.v17i1.8530
[21] Fukino N, Kunisiha M, Matsumoto S. 2004. Characterization of Recombinant Inbred Lines Derived from Crosses in Melon (Cucumis melo L.). Journal Breeding Science 5(3): 141- 145
[22] Gombart AF, Pierre A, Maggini S. 2020. A review of micronutrients and the immune system–working in harmony to reduce the risk of infection. Nutrients. 10.3390/nu12010236. 12(1): 236. Doi: 10.3390/nu12010236
[23] Gonzalez B, Arca P, Mayo N, Suarez JE. 1994. Detection, purification, and partial characterization of plantaricin C, a bacteriosin produced by a Lactobacillus plantarum strain of dairy origin. Appl Environ Microbiol. 61:2873–2878.
[24] Hyson. 2005. Smoothies: Exploring the Attitudes, Beliefs and Behaviours of Consumers and Non-Consumers McCartney D, Rattray M, Desbrow B, Khalesi S, Irwin C. 2018. Current Research in Nutrition and Food Science Journal. 6(2):425-436. ISSN: 2347-467X.
[25] Jayawardena R, Sooriyaarachchi P, Chourdakis M, Jeewandara C, Ranasinghe P. 2020. Enhancing immunity in viral infections, with special emphasis on COVID-19: A review. Diabetes MetabSyndr Clin Res Rev. doi: 10.1016/j.dsx.2020.04.015.
[26] Kadkhoda G, Zarkesh M, Saidpour A, Oghaz MH, Hedayati M, Khalaj A. 2020. Association of dietary intake of fruit and green vegetables with PTEN and P53 mRNA gene expression in visceral and subcutaneous adipose tissues of obese and non-obese adults, Gene, 733,144353.
[27] Kemenkes RI. 2014. Angka Kecukupan Gizi yang Dianjurkan Bagi Bangsa Indonesia. Jakarta. Direktorat Jenderal Bina Gizi dan Kesehatan Ibu dan Anak, Kementerian Kesehatan Republik Indonesia.
[28] Kemenkes RI. 2018. Konsumsi Makanan Penduduk Indonesia. Jakarta: Pusat Data dan Informasi Kementerian Kesehatan RI.
[29] Kimura M, Kobori CN, Rodriguez-Amaya DB, Nestel P. 2007. Screening and HPLC methods for carotenoids in sweetpotato, cassava and maize for plant breeding trials. Food Chemistry. 100(4):1734-1746
[30] Koswara S. 2009. Jahe dan Hasil Olahannya. Pustaka Sinar Harapan. Jakarta.
[31] Kumar M, Bedi B, Gupta M, Kumar S, Jaiswal G, Rahi V, Yedke NG, Bijalwan A, Sharma S, and Jamwal S. 2021. Role of vitamins and minerals as immunity boosters in COVID-19. Inflammopharmacology. 10 : 1–16. doi: 10.1007/s10787-021-00826-7
[32] Lim TK. Pouteria campechiana. In Edible Medicinal and Non-Medicinal Plants, 2013, 6:133-137. Fruits New York, NY, USA: Springer. Doi:10.1007/978-94- 007-5628-1_23.
[33] Lobo V, Patil A, Phatak A, and N. Chandra. 2010. Free radicals, antioxidants and functional foods: Impact on human health. Pharmacogn Rev. 4(8): 118–126. doi: 10.4103/0973-7847.70902
[34]
[35] Luo Y, Li Y, Dai J. 2020. Low blood sodium increases risk and severity of COVID-19: a systematic review, meta-analysis and retrospective cohort study. medRxiv. Doi: 10.1101/2020.05.18.20102509
[36] Micronutrients. https://www.unicef.org/nutrition/index_iodine.html.
[37] Murillo E, Meléndez-Martínez AJ, Portugal F. 2010. Screening of vegetables and fruits from Panama for rich sources of lutein and zeaxanthin. Food Chemistry.122(1): 167–172. https://doi.org/10.1016/j.foodchem.2010.02.034.
[38] Nelson, N., 1944. A photometric adaptation of the Somogyi method for the determination of glucose. Journal Biol. Chem, 153(2), 375-379.
[39] Ni W, Yang X, Yang D, Bao J, Li R, Xiao Y. 2020. Role of angiotensin-converting enzyme 2 (ACE2) in COVID-19. Crit Care. 24(1):1–10. Doi: 10.1186/s13054-020-03120-0.
[40] Niagara, Daningsih E, Titin. 2018. Sifat fisik dan kandungan gizi buah peluntan, senare, dan ara' di kalimantan barat. Edukasi: Jurnal Pendidikan. 16(1): 68-71

[41] Nurjanah S. 2002. Kajian Laju Respirasi dan Produksi Etilen sebagai Dasar Penentuan Waktu Simpan Sayuran dan Buah-buahan. Jurnal Bionatura. 4(3): 148-156.
[42] Orwa, C., Mutua, A., Kindt, R., Jamnadass, R., Anthony, S., 2009. Agroforestree Database: A Tree Reference and Selection Guide Version 4.0. World Agroforestry Centre, Kenya.
[43] Oshima S, Hirano A, Kamikado H, Nishimura J, Kawai Y, Saito T. 2013. Nisin A extends the shelf life of high-fat chilled dairy dessert, a milk-based pudding. Journal of Applied Microbiology. Doi:10.1111/jam.12454. 116:1218-1228.
[44] PORIM. 1995. PORIM Test Methods. Palm Oil Research Institute of Malaysia, Kuala Lumpur
[45] Pushpakumara DKNG. 2007. Lavulu Pouteria campechiana Kunth Baehni. In D. K. N. G. Pushpakumara, H. P.
[46] M. Gunasena, & V. P. Singh (Eds.), Underutilized fruit trees in Sri Lanka (pp. 426–436). World Agroforestry Centre.
[47] Rai S dan Chauhan AS. 2008. Quality attributes of drum-dried papaya-cereal flakes developed from ripe papaya (Carica papaya L.). Electronic J Environ Agric Food Chem. 7(5): 2914-2931.
[48] Ramanaboina A, Bhavya N, Tangirala ADS, Jayamma P. 2020. Study of physico-chemical properties of mosambi jelly. International Journal of Chemical Studies. 8(5): 1663-1672 Doi: https://doi.org/10.22271/chemi.2020.v8.i5w.10537.
[49] Rodriguez-Morales AJ, Cardona-Ospina JA, Gutiérrez-Ocampo E, Villamizar-Peña R, Holguin-Rivera Y, Escalera-Antezana JP. 2020. Clinical, laboratory and imaging features of COVID-19: A systematic review and meta-analysis. Travel Med Infect Dis. Doi: 10.1016/j.tmaid.2020.101623
[50] Shaikh dam Gadhe. 2020. Studies on development and quality evaluation of cupcake fortified with flaxseed and chia seed flour. The Pharma Innovation Journal. 9(7): 214-217
[51] Shakoor H, Feehan J, Al Dhaheri AS, Ali HI, Platat C. 2021. Immune-boosting role of vitamins D, C, E, zinc, selenium and omega-3 fatty acids: Could they help against COVID-19? Maturitas.143.
[52] Stevenson A. 2003. Cake Definition. Oxford Dictionary of English, Oxford University Press, United Kingdom.
[53] Verheij Amaya DBR, Kimura M. 2004. Harvest Plus Handbook for Carotenoids Analysis. USA: Harvest Plus.
[54] Wintergerst ES, Maggini S, Hornig DH. Contribution of selected vitamins and trace elements to immune function. Ann Nutr Metab. 2007;51(4):301-23.
[55] Yadav AK dan Singh S V. 2014. Osmotic dehydration of fruits and vegetables: a review. J Food Sci Technol. 51(9):1654–1673.
[56] Yahia EM. 2004. Sapodilla and related fruits', in: U.S. Dept. Agric. Agric. Handbook. Available from http://www.ba.ars.usda.gov/hb66/index.html.
[57] Yao J, Liu Y, Zhou S. 2019. Effect of Eating Breakfast on Cognitive Development of Elementary and Middle School Students: An Empirical Study Using Large-Scale Provincial Survey Data. Med Sci Monit. 25: 8843–8853. doi: 10.12659/MSM.920459
[58] Zabetakis I, Lordan R, Norton C, Tsoupras A. 2020. COVID-19: The Inflammation Link and the Role of Nutrition in Potential Mitigation. Nutrients. 19;12(5):1466. Doi: 10.3390/nu12051466.