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A Study of Stability of Kenaf Leaves Herbal Tea Integrated with *Prunus Persica* (Peach) Extract

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DECLARATION

I declare that this thesis entitled "A Study of Stability of Kenaf Leaves Herbal Tea Integrated with *Prunus Persica* (Peach) Extract" is the results of my own research except as cited in the references.

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Date : 18th February 2022

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A Study of Stability of Kenaf Leaves Herbal Tea Integrated with *Prunus Persica* (Peach) Extract

ABSTRACT

Kenaf or *Hibiscus cannabinus L* is a fibrous plant that usually planted in African and Asian countries. Kenaf has a lot of benefits due to its phytochemical contents. These benefits can be obtained through various usages, such as consuming it as kenaf herbal tea. Therefore, this research was focusing on kenaf herbal tea integrated with peach extract as a flavouring. This study had formulated the peach flavoured kenaf herbal tea and analysed its stability in different packaging. The research methods were the development of kenaf herbal tea with five formulations and the stability analysis which involved pH, moisture content, and colour analysis in two types of packaging. The analyses were then interpretated statistically by using two-ways ANOVA method in IBM SPSS Statistics software. This result showed that there was significant difference in pH on comparative analysis between each formulation, while unsignificant difference between pH and packaging, and between pH with each formulation and packaging. The moisture content and colour also showed there were no significant different between each of the comparative analysis.

Keywords: kenaf, herbal tea, peach, stability, packaging, flavour

Kajian Kestabilan Teh Herba Daun Kenaf Dicampur dengan Ekstrak *Prunus Persica* (Pic)

ABSTRAK

Kenaf atau *Hibiscus cannabinus L* merupakan tumbuhan gentian yang umumnya ditanam di negara Afrika dan Asia. Kenaf mempunyai pelbagai khasiat kerana kandungan fitokimianya. Faedah ini boleh dimanfaatkan melalui pelbagai cara penggunaan, seperti menggunakannya sebagai teh herba yang diperbuat daripada kenaf. Oleh itu, kajian ini tertumpu kepada teh herba kenaf yang disepadukan dengan ekstrak pic sebagai perisa. Kajian ini telah merumuskan teh herba kenaf berperisa pic dan menganalisis kestabilannya dalam pembungkusan yang berbeza. Kaedah kajian adalah pembuatan teh herba kenaf dengan lima formulasi dan analisis kestabilan yang melibatkan analisis pH, kandungan lembapan, dan warna dalam dua jenis pembungkusan. Analisis kemudiannya ditafsirkan secara statistik dengan menggunakan kaedah ANOVA dua hala dalam perisian IBM SPSS Statistics. Keputusan ini menunjukkan terdapat perbezaan pH yang signifikan pada analisis perbandingan antara setiap formulasi, manakala perbezaan tidak signifikan antara pH dan pembungkusan, dan antara pH dengan setiap formulasi dan pembungkusan. Kandungan lembapan dan warna juga menunjukkan tidak terdapat perbezaan yang signifikan antara setiap analisis perbandingan.

Kata kunci: kenaf, teh herba, pic, kestabilan, pembungkusan, perisa

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LISTS OF ABBREVIATIONS

Abbreviations	Description
ANOVA	Analyses of Variance
CAGR	Compound Annual Growth Rate
CIE	International Commission on Illumination
FFTC-AP	FFTC Agricultural Policy Platform
G	Ginger granules
g	Gram
hrs	Hours
INTROP	Institute of Tropical Forestry and Forest Products
K	Kenaf leaf granules
L	Lemongrass granules
LGM	Malaysian Rubber Board
MARDI	Malaysian Agriculture Research Development Institute
min	Minutes
ml	Millilitre
mm	Millimetre
MPOB	Malaysian Palm Oil Board
NKTB	National Kenaf and Tobacco Board
P	Peach powder
P	P-value

pH	Potential of hydrogen
SPSS	Statistical Package for the Social Sciences
UKM	Universiti Malaysia Kelantan
UPM	Universiti Putra Malaysia
USA	United States of America

LIST OF SYMBOLS

Symbol	Description
%	Percentage
°C	Degree Celsius
L*	Perceptual lightness
a*	Four unique colours of human vision: red, green
b*	Four unique colours of human vision: blue, yellow
×	Multiplication
÷	Division or divide
>	Greater than
<	Lesser than

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Kenaf or *Hibiscus cannabinus L* is an African plant that is hibiscus. It is planted agriculturally for manufacturing of paper and ropes, by refining its fibre (M. M. Nor et al., 2019). Besides their function as non-food production, as M. H. A. Basri et al. (2014) stated, kenaf also contains many beneficial nutrients such as anticancer component and phenolic substances. According to R.W. Hansen. (1981), kenaf contains both macronutrients and micronutrients: Iron, Manganese, Zinc, Copper, Nitrogen, Potassium, Phosphorus, Sodium, Calcium, and Magnesium. These nutrients can be found in the bark, wood, seeds and kenaf's tops, plus foliage. Moreover, all part of kenaf plant can be fully utilized into a beneficial product without waste (M. H. A. Basri et al., 2014). Kenaf leaves are easier to digest compared to its stems, which made kenaf is very suitable as animal feed, besides its feed efficiency is comparable to alfalfa hay (Ammar. H. et al., 2020). In addition, kenaf leaves contains medicinal properties which is good for human health, which is attributed to 13 phytochemicals. The kaempferitrin was also found in Kenaf leaves which was known to help in blood glucose levels and impact macrophage cells which are decreasing in lipid peroxidation, anti-inflammatory and antimicrobial (Jorge et al., 2004; Jin et al., 2013; Zhao et al., 2014). Therefore, this bioactive compound containing in kenaf can be fully utilized as a food product, such as herbal tea (MM Nor et al., 2019). In order to attract more consumer preference towards herbal teas, adding peach as flavouring may help. Adding the taste can be done by diffusing peach flavour together with the Kenaf leaves.

1.2 Problem Statement

Functional food such as herbal teas is kept increasing in demand among Malaysians due to health concern and health promotion (Teck-Chai Lau. et al., 2012). As stated by Agri-Food Trade Service in "Consumer Trends: Functional Food" report, *the annual growth rate for functional foods in 2009 are about 8% to 14%*. However, based on the study by Food and Fertilizer Technology Centre for the Asian and Pacific Region or FFTC Agricultural Policy Platform (FFTC-AP), the market size of functional food in Malaysia is still low within years compared to other Asia Pacific countries such as Indonesia, Philippines, and Thailand, as shown in Figure 1.1 below. In addition, the benefits of kenaf plant are not fully utilised as the leaves were not in use for anything and were treated as a waste although kenaf leaves contains a lot of phytochemicals such as flavonoids which able to provide huge health benefits to the consumers. Therefore, this research was to attract and produce more functional teas, by utilising the kenaf leaves as flavoured kenaf herbal tea.

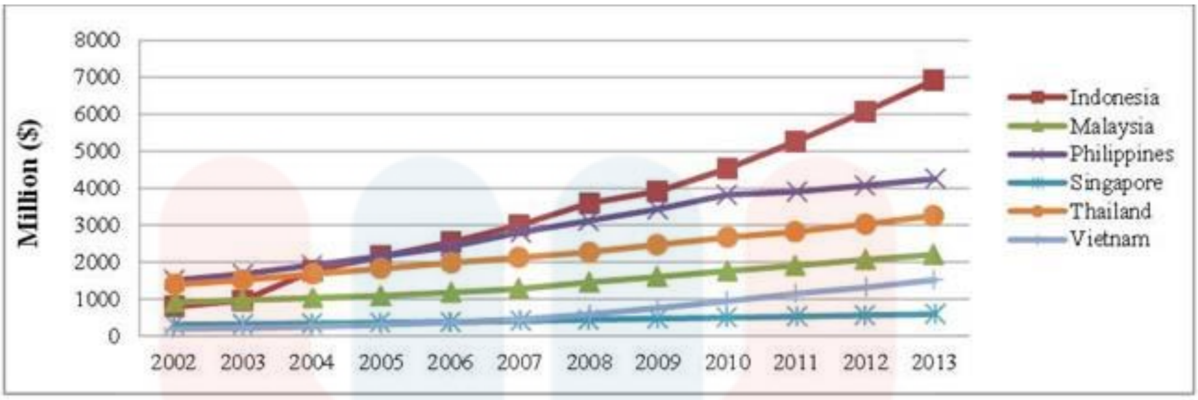

Figure 1. 1: Market size of functional food in Asia by FFTC. (Source: FFTC-AP)

1.3 Hypothesis

H_0: There is no significant interaction between the packaging and formulation on the stability of Peach Flavoured Kenaf Herbal Tea pH, moisture, and colour.

H_a: There is significant interaction between the packaging and formulation on the stability of Peach Flavoured Kenaf Herbal Tea pH, moisture, and colour.

1.4 Objectives

a. To formulate new flavours of kenaf leaves herbal tea.

b. To study the stability during storage of kenaf leaves herbal tea in normal plastic packaging and vacuum packaging.

1.5 Scope of Study

The scope of this study was to conduct research regarding the flavoured Kenaf herbal tea. The flavour chosen was peach flavour as the sweetness, and fruity taste of peach will help to overcome the bitterness of original unflavoured kenaf herbal tea. The flavoured kenaf herbal tea were examined by its stability during storage in different packaging by analysing the pH value, moisture content, and colour of five formulations of peach flavoured kenaf herbal tea and positive control sample. The stability tests were done in two types of packaging which were normal plastics packaging and vacuum packs for 30 days or one month only due to the time constraints to follow the prescribed syllabus.

1.6 Significance of Study

Kenaf crop may help protect the biodiversity as it is a non-wood crop that can fulfil the need for some industrial raw material such as paper. Besides, the government also found that tobacco can be replaced with kenaf, which shows that a single crop or type of plant is able to give a lot of advantages and produce various usage or by-product (M. H. A. Basri et al., 2014). In addition, researches regarding Kenaf in Malaysia is in progress and mainly were carried out by Malaysian Agriculture Research Development Institute (MARDI). This shows that kenaf has a very bright future to help the local farmers and boost economic production. As stated by Ahmad. F. et al. (2015), herbal supplement as a substitution of modern medicine has an increase in demand among consumers. The Global Industry Analysts Inc. also stated that the compound annual growth rate (CAGR) of the herbal industry is 9.1%, which is led by Europe and Asia-Pacific countries. Based on the findings paper by Ahmad. F. et al. (2015), the highest herbal practice is the western herbalism which is 50.9%, while 34.6% is from the Chinese Traditional, followed by Homeopathy which is 8.2%, and lastly is 6.3% by Hindu's traditional medicine system, Ayurveda. Kenaf leaves is one of the best ingredients to make the herbal tea as it contains a lot of phytochemicals. Extraction by using 95% ethanol from kenaf leaves able to produce phenols, flavonoids, alkaloids, and tannin (M. M. Nor., et al., 2019). The amount of antioxidant activity is high, especially in the old Kenaf leaves, which is 81.13%, compared to young kenaf leaves which are 80.47% (M. M. Nor., et al., 2019). Therefore, Kenaf leaves' production as herbal teas have a very bright future in promoting the local's economic growth and improving the consumers' health due to its nutrient contents.

CHAPTER 2

LITERATURE REVIEW

2.1 Kenaf Plant

Kenaf is classified as Furcaria under the Hibiscus genus. It is a type of plant with a high level of stress tolerance and adaptability, besides high in yield and fast-growing. Kenaf can usually be found in tropical and subtropical climate country especially in Africa and Asia. In semiarid climates, such as those found in the Mediterranean region, the crop is adaptive, achieving high amounts of production with just 250 to 400 mm of water, much lesser than maize and alfalfa (Alexopoulou et al., 2009).

Farmers can readily embrace it as an annual crop, and it can be cultivated in rotation with traditional food crops. As a result, it can boost biodiversity, internal nutrient recycling, long-term land productivity, and crop yields by preventing mono-cropping-related diseases and pests (Zegada-Lizarazu & Monti, 2011). It's commonly used as a fibre crop and animal feed, and it's well-known as a fibre material for fibre items like paper, rope, and pulp (Xu. J. et al., 2020). Its fibres are used to make high-quality paper, bio-composites for car door trims, interior shelving, bioplastics, and construction materials like medium density fibreboard, textile, and furniture.

Aside from the fibrous stem, the other sections of the kenaf like flower, seed, and leaves are often considered low-value agricultural by-products. A few research has been conducted in these recent years to develop kenaf by-products as a value-added ingredient in the pharmaceutical and food industries. Kenaf has long been used in Africa and India as a popular medicine to cure a variety of illnesses, including anaemia and exhaustion (Jin, Ghimeray, Wang, Xu, Piao & Cho, 2013).

2.2 Kenaf in Malaysia

Hibiscus Cannabinus L. or Kenaf leaves is a fibrous tree from Malvacaeae that is almost the same as a cotton crop. As stated by the National Kenaf and Tobacco Board (NKTB) by the Ministry of Plantation Industries and Commodities, Kenaf was introduced by MARDI, LGM, MPOB and UPM in the year 2000 for research and development and familiarisation crop in 2004 which were in Kelantan and Terengganu before introducing kenaf all over Malaysia in the year 2010. The seed production for Kenaf is largely cultivate in Kedah and Perlis, while the production for fibre and kenaf core are in Johor, Perak, Selangor, Terengganu, Pahang, Kelantan and Negeri Sembilan (NKTB n.d.). Therefore, to increase further usage of kenaf, a few research were made, including the morphology and physiology of the kenaf, to explore the potential usage and its adaptability in Malaysia's climate.

Besides, there are findings that kenaf's chemical composition is very suitable for papermaking, as it fulfils the grade made by the Pulp and Paper Industry of Malaysia (M. H. A. Basri et al. 2014). In addition, NKTB aimed to use kenaf as a replacement of tobacco crop. Tan Y. L. et al. (2017) stated that kenaf is able to significantly consume carbon dioxide and absorb phosphorus and nitrogen from the soil.

In addition, kenaf also able to reduce the greenhouse gasses and needs lesser chemical compounds such as pesticides and fertilizer during cultivation, as compared to other common crops like corn crop, and with these abilities it made kenaf as an eco-friendly and an excellent crop to improve the environment. In economic aspects, kenaf fibre was exported from Malaysia, where the total sales value keeps on increasing within years where in 2016 it worth RM1.14 million, and RM 1.68 million in 2017 (Tan Y. L. et al. 2017).

There are 32 genotypes of kenaf cultivated in Malaysia which their origins were from various country in the world (Faruq, G. et al., 2013). Most of these genotypes have different traits such as the height, diameter, nodes number, leaves length, width and angle, petal, maturity period, stick and weight of fibres. These characteristic and varieties studies may help in the development of effective farming practices for higher yielding adapted species in order to develop a sustainable ecosystem in Malaysia, through the use of raw fibre resources.

2.3 Kenaf Varieties

MARDI and the Institute of Tropical Forestry and Forest Products (INTROP) had conducted detailed research on Kenaf species. A few species of selected kenaf genetic variability were introduced and planted in experimental sites at MARDI Serdang Station in Malaysia.

There are three types of flowering period planted in Malaysia, which are early flowering, moderate and slow flowering kenaf. The 17 kenaf crops that have been planted with moderate flowering are Sabdariffa Keewyai, V4, V12, V36, V21, V23, V25, V33, V34, V40, V41, and V72 (H'ng, P. S., et al., 2009). Table 2.1 shows the variety of kenaf planted in MARDI experimental sites.

Table 2. 1: The variety of kenaf according to the flowering period.

Flowering Period	Kenaf Variety
Early	V13, V19 (red and green stem), Khon Kaen 60, Tainung 2, Q-Ping
Moderate	Sabdariffa Keewyai, V4, V12, V36, V21, V23, V25, V33, V34, V40, V41, V72
Late	V133, TK, KB-6, K114-2

Source: MARDI experimental sites.

The new kenaf varieties introduced in Malaysia are Q-Ping, KK60, V12, V19, V36, V132, NS V133 and TK (H'ng, P. S., et al., 2009). The studies by H'ng, P. S., et al. (2009) showed that most of the tissues in these plants formed almost the same, except for V19 and V12 species with a larger ray cell. In addition, kenaf varieties identification can be made by evaluating the fibre morphology which are the lumen diameter, fibre, and length, as these parameters are different in each species.

According to Golam F., (2011), the other variants of kenaf from other countries such as Kenya, China, Australia, and USA can be seen in Table 2.2.

Table 2. 2: Kenaf variations from Kenya, China, Australia, and USA.

Country	Kenaf variety
Kenya	E16, E17, E20, E23
China	E66, E67, E70, E71
Australia	E60, E62, E58, E59
USA	E52, E56, E03, E10

Source: Golam F., (2011).

2.4 Nutritional Value and Health Benefits of Kenaf Leaves

Kenaf is made up of four essential parts which these parts have their own benefits and usage. The parts are seeds, flowers, leaves, and stems. Each of the kenaf parts has different uses. The kenaf stems have a length of 1 to 2 m. Its flowers have various colours which are either white, purple, or yellow with diameter of 8 to 15 cm. Kenaf have fruit of 2 cm diameter with several seeds inside. Kenaf leaves have various shapes from a whole-leaf shape until hemp-like shape or palmate leaf with a few edges (KEFI S.p.A., n.d.). Kenaf leaves are used as a crop because they are high in antioxidants and phenolic material (Ryu et al., 2017).

Although the leaf in general was historically thought to be waste, it has been shown to contain high levels of antioxidant-rich oil (Chan & Ismail, 2009; Ryu et al., 2017). Kenaf can be used as a substitution of edible oil in daily life usage due to its special composition (Chan & Ismail, 2009; Cheng, et al., 2016; Mariod, et al., 2010).

Kenaf leaf extract is high in phenolic and flavonoid (Adnan, M., et al., (2020). Due to this, the parts of kenaf is known to be used as an important plant-based medicine, especially in Asia (Alexopoulou, et al., 2013; Ryu et al., 2013). Kenaf may be used as potential ingredients in plant by-product due to the nutritional and phytochemical contents present in the various kenaf parts, especially the seed and leaf (Ibrahim. S. G., et al., 2019). Modern pharmacological research has shown that kenaf has antibacterial, anticancer, anti-inflammatory, antiulcer, antityrosinase, antihyperlipidemic, and antioxidant properties. The kenaf leaves can also be used as food additives (Ryu et al., 2017).

Cytotoxicity and anticancer studies on kenaf leaf extract were made by Adnan, M., et al., (2020), which involved the mouse's embryo for cytotoxicity, and cancerous lung tissue for anticancer study. As the result, there were no cytotoxicity effects on the cell besides the cells grows healthily, which may be due to the high phytochemicals content in kenaf leaves extract. The anticancer studies showed that the kenaf leaf extract was able to suppress the growth of cancer cells in the cancerous lung tissue sample. Besides, the high contents of phytochemicals also related to the high in antioxidant activities or high free radical scavenger in the kenaf leaf extract.

There is wide usage of kenaf as food, beverages, and medicinal purposes, especially in an African country. Therefore, there were a few studies regarding the phytochemical in kenaf chemical properties such as in Agbor. G., et al. (2004). The result of the research by Agbor. G., et al. (2004), by in vitro and in vivo on mice showed the oral consumption of kenaf leaf extract is safe although it contains a lot of phytochemicals such as tannins, flavonoids, and phenolic compounds. However, direct usage of kenaf leaf extract such as injecting the extract into veins or sniffing will cause negative effects towards the body including increasing in reactivity which can lead to seizures and death.

Bilirubin concentration, aspartate aminotransferase and alanine aminotransferase enzymatic activities were observed in order to know the effects of kenaf leaf extract in the liver for hepatocellular damage testing. The result shows that there were no critical impacts towards the liver in vivo testing. The liver histology was also the same during the experiment, which shows that there were no hepatotoxic effects which showed that consuming kenaf leaves as herbal tea is safe (Agbor. G., et al., 2004).

The components that is related with renal function, which are creatinine and urea were also tested, where high concentration of these components is related with heart failure and gastrointestinal bleeding. The result shows that kenaf leaf extract does not interfere with these parameters. The studies by Agbor. G., et al. (2004) also showed that kenaf leaf extract might help in reducing the atherosclerosis effects by lowering the cholesterol serum level on the tested mice. In addition, there was also decreasing in glucose level on the test of the mice. Further studies may need to identify the hyperglycaemia treatment by using kenaf leaf extract.

According to pharmacology research on kenaf herbal extract by Adnan, M., et al., (2020), there was no toxicity found during studies on the mouse's embryo cells and on the cancerous human lung tissue sample. The study conducted by Adnan, M., et al., (2020) also showed the antibacterial activity in the kenaf leaf extract. This maybe attributed to presence of the natural properties in kenaf leaf like phenols and flavonoids containing in this extract that can cause the weakening of the bacterial membrane or by interacting with normal bacterial metabolic processes.

2.5 Kenaf Herbal Teas

Plant-based food product and medicine are getting more attention due to their natural content and health benefits. As tea is known as the number two of the most consumed drink, there are increasing in the development of herbal tea development from various types of beneficial leaves (Haw, Y. T., et al., 2020). The leaves contain varieties of chemical compounds, where the majority of them are non-nutritive dietary content that are useful to human health. These substances are known as phytochemicals. Phytochemicals are chemical substances that are produced during the natural metabolic activities of plants. The example of phytochemicals are tannins, phenols, and flavonoids (Omenna EC, & Ojo AI., 2018).

Although kenaf leaves are known as waste material in the industry, it was actually used as traditional medicine purposes such as for liver disease and anaemia. African also uses kenaf leaves as vegetables and beverage (Agbor. G., et al., 2004). Some of the kenaf herbal tea was prepared by steam blanching, known to inactivate the enzymatic oxidation for quality preservation. The preparation of kenaf herbal tea is simply by collecting the leaves needed, wash and dry them. The dried leaves will then be grinded in order to turn it into powder. To examine the kenaf herbal tea, the extract of the leaf is needed. Therefore, it can be extracted in ethanol solutions (M. M. Nor et al., 2019).

In ad study by Haw, Y.T., et al., (2020), the kenaf leaves herbal tea preparation technique were compared between steam blanched kenaf herbal tea and the traditional way of herbal tea which was without steam blanching. The result showed that the preparation that includes steam blanched in herbal tea making produced the best results, including better consumers' preference and the quality of the kenaf herbal tea such as the colour and high phenolic content. Besides, they found that the sour taste of kenaf herbal tea was due to the high in phenolic content with low pH level.

Findings by Wisu, K. et al., (2007) which stated that the active ingredients in kenaf herbal tea are higher than in green tea content. When kenaf herbal tea was heat-treated, a lot of bioactive components will be extracted into the water. As suggested by Wisu, K., et al., (2007), it is better to treat the leaves in the heat of 60 °C for 45 min, either by using hot water or far-infrared treatment. In addition, research made by Jin, C. W., et al., (2013), concluded that the kenaf leaves herbal tea, which uses far-infrared during preparation with 60

°C for 30 min, is one of the best procedures and gives better results in terms of the phenolic compounds and antioxidants activity.

2.6 Flavoured Herbal Teas

There is a lot of commercialized flavoured herbal tea. Based on the studies done by Chang, S. C., & Pathiassana, M. T. (2017) regarding the preference of youngsters towards green tea, they found out that 53% chooses the taste out of the three preference factors, instead of the health benefits or habits. This shows that the taste of the herbal tea is important in attracting the consumer. The consumers' evaluation also stated that they choose less bitter tea and lesser intense tea taste.

There were studies between flavoured tea and fruit tea which evaluates the chemical properties between those teas. The research was conducted by Pękal, A., et al., (2011). The results of the study showed that the polyphenol in flavoured tea was higher than the fruit tea. The antioxidant properties in flavoured tea were also higher than in fruit tea.

As the studies made regarding the consumer's preference of rooibos iced tea and lemon flavoured rooibos iced tea by Viljoen, M., et al., (2017), the addition of flavours in herbal tea may help in the acceptability of the consumers towards the herbal, as the lemon flavour in rooibos iced tea were able to help in influencing the taste of the natural favour of the tea. Consumers also prefer the "red-brown" herbal tea colour instead of the "yellowish-orange" colour. Some studies have found that the overall perception of the product is on the flavour or taste of the products, rather than its positive effects, which this is the key factors for consumer acceptance of food products (Viljoen, M., et al., 2017).

2.7 Peach as Flavouring

Peach or *Prunus persica* is a well-known fruit and consumer’s favourite flavour due to its exotic taste alongside with their high nutritional benefits (Wanpeng, X. I., et al, 2017). As stated by Wanpeng, X. I., et al (2017), the quality of fruit flavour is based on the aroma produced by them, together with the taste such as sour and sweet, as their study found out that the highest sugar in peach fruit is sucrose which makes peaches have sweet taste as sucrose act as sweetener besides providing energy. However, some consumers stated that peach are lack of sweet taste or lack of sugar (Cantín, C. M., Gogorcena, Y., & Moreno, M. Á., 2009). This is due to the fructose concentration level in peach is low, as fructose is the key factor for quality of fruit flavour by reason of its notable sweetness compared than other groups of sugar (Pangborn, R. M., 1963).

2.8 Storage Stability Study of Herbal Teas

Herbal tea leaves contain organic compounds that can be an aid in plant protection against aggressive phytopathogens and have been shown to have health benefits when consumed as part of a diet (Ho. Et al., 2009). Polyphenolic tea catechins are among these secondary metabolites.

However, the research conducted by Friedman, M., et al., (2006) showed that catechins in commercial tea leaves might not be stable during long-term solid-state storage. Tea may be preserved for long periods of time because it is not vulnerable to spoilage. However, catechin oxidation in commercial tea leaves stored in factories, restaurants, supermarkets, and homes may reduce tea's possible health benefits. Added additives influenced catechin stability in commercial tea drinks during storage. The usage of additional stabilizing catechins and a controlled temperature of 4 °C, pH 5.5, a low oxygen environment, stored in the dark, and the use of filtered, metal-free water, can reduce the oxidation of tea catechin in tea beverages.

According to Sedaghathoor. S. et al. (2013), the overall moisture content of tea samples after one year of storage was 6.05 %, which is 0.5 % higher than the original moisture content. According to Iranian national guidelines, the optimal amount of moisture in packaged tea is 7%. Hence, a moisture increases of 0.5 % is acceptable. Choosing a good packaging material which are able to avoid the moisture from entering in the tea is important. Therefore, paperboard packaging with a lining and cover may help in moisture avoidance. Increases in certain aromatic compounds after one year may have occurred as a result of lower levels of some aromatic compounds found in tea.

Extended storage of herbal tea may also cause in lowering of the quality of the tea as the oxidation process may occur due to the presence of air (Sedaghathoor. S. et al. (2013). Long storage also will cause in loss of aromatic compound in herbal tea, which decreases the taste of the tea. This is might due to the alterations in thearubigin and theaflavin. According to Springett et. al. (1994), after 16 and 48 weeks of storage, the major change in the volatile pattern of tea samples was an increase in the standard air pack compared to the zero-time sample and the vacuum and nitrogen flushed sample. The findings suggest that changes in aroma quality of black tea leaf during storage can occur due to oxidative deterioration, and that this change in aroma pattern can be mitigated to some extent by using packaging regimes that exclude air from the pack.

According to Cheong. A. M. (2018), the most significant degradation was seen in nano emulsions stored at a high temperature which are 40 °C. The vitamin E stability storage results showed that present vitamin E content in kenaf was well condensed, covered, and stored throughout storage of week eight and twelve. The strong antioxidant activity of Sodium Caseinate, which was used as the key emulsifier to condense kenaf, not only provided encapsulation shield for the bioactive compounds in nano emulsions, but it also reduced the rate of oxidation and decreases in quality of bioactive compounds in nano emulsions, particularly when kept refrigerated.

According to Jin et. al. (2016), Herbal teas' antioxidant property values and colour parameters varied more than green teas. Apart from a few herbal teas with high antioxidant property values that could be analogous or superior to green teas, most herbal teas had lower antioxidant property values than green teas. The results of their studies showed that herbal teas had more diverse colour parameters of tea samples than green teas. Meanwhile, the content of theaflavins and thearubigins in tea respectively increases and decreases the 'brightness' measured by reflection, as well as the 'brightness' measured by transmission. (Smith and White, 1965).

CHAPTER 3

3. METHODOLOGY

3.1 Experimental Design

The Figure 3.1 below shows the flowchart of the processes for Peach Flavoured Kenaf Herbal Tea throughout the semester.

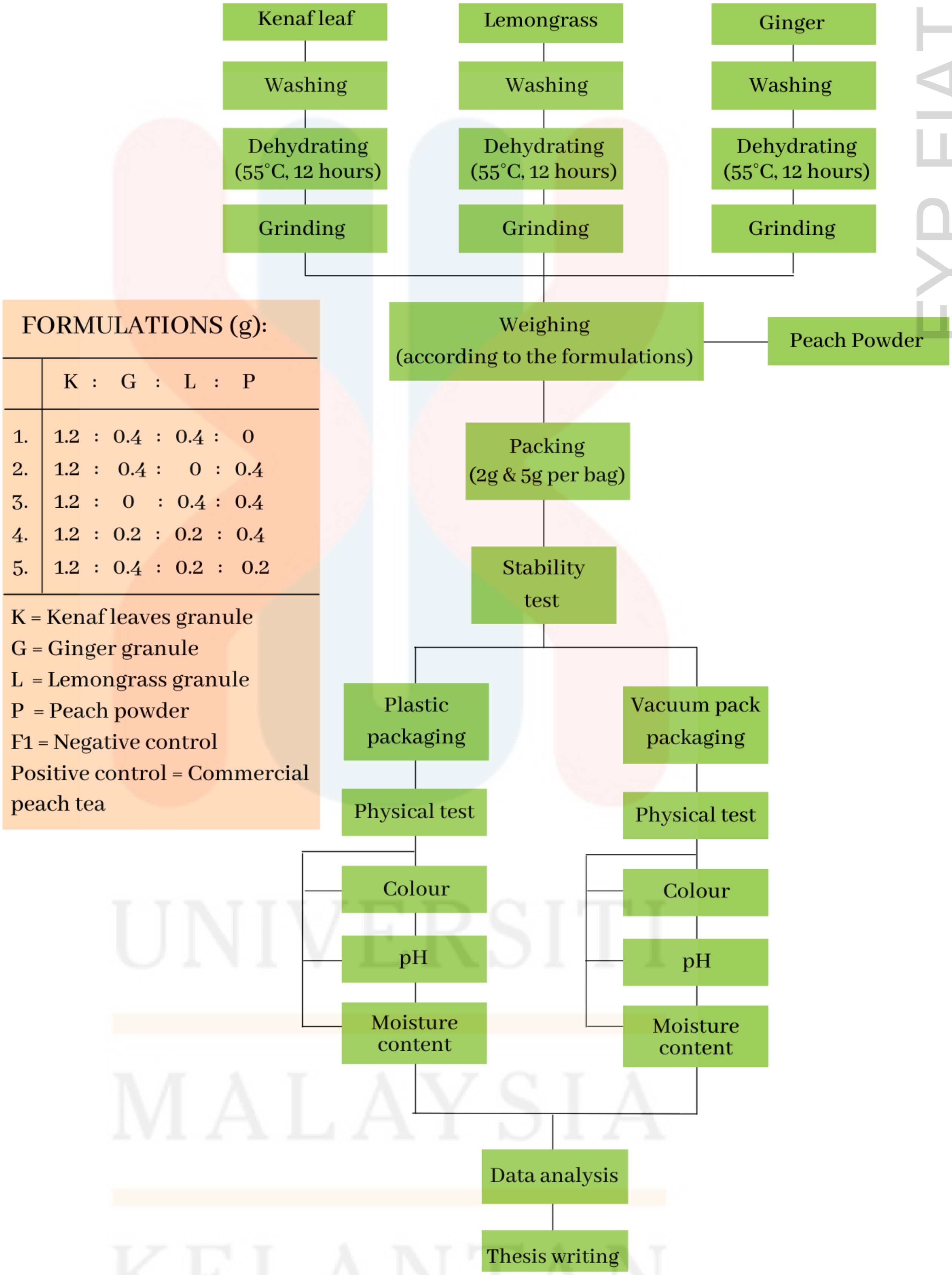

Figure 3. 1: Flowchart of the processes for Peach Flavoured Kenaf Herbal Tea.

3.2 Materials and Equipment

The material was kenaf leaves that harvested from Kenaf Orchard, Bukit Bunga, Kelantan, and peach flavour powder extract were purchased from Shopee online purchasing platform. The Peach Oolong tea for positive control were also purchased from Shopee online shop. Lemongrass has been taken from around UMK, while fresh gingers were purchased from the grocery store near UMK. The equipment used were empty teabags purchased from Shopee online store, gloves, beaker, dropper, plastic bags, vacuum packs, laboratory analytical digital weighing scale, dehydrator, food processor, spectrophotometer, vacuum machine, and sealer machine.

Figure 3. 2: Kenaf Orchard, Bukit Bunga, Kelantan.

3.3 Preparation of Flavoured Kenaf Herbal Tea

The kenaf herbal tea preparation was according to the method stated by M. M. Nor et al. (2019), Kaur et al. (2016), and RO Situmorang and AD Sunandar (2019).

The parts of kenaf such as its leaves, stalks, and flowers were separated from each other, and wilted leaves were segregated before weighed and washed. Lemongrass and ginger were washed, weighed, and chopped separately. These ingredients were then dried separately in the dehydrator machine at the temperature of 50 °C for 12 hrs. Due to the study by Mujaffar, S., & John, S. (2018), leaves that were dried at lower temperature which were around 40 °C to 50 °C will be able to retain its quality in terms of colour and aroma, compared to higher temperature which was 70 °C will cause worsening in the leaf's quality. While drying at 30 °C was bad as it caused fungal growth. These dried ingredients were then weighed before grinded into small coarse by using food processor.

Figure 3. 3: The grinded raw materials: kenaf leaves, ginger, and lemongrass.

The weight of raw ingredients for the samples were collected during the drying processes to get total percentage yield or the percentage of water loss for the crops by collecting the weight of the ingredients before drying and after drying. The formula used was as below:

$$\text{Total Yield (\%)} = (\text{After} \div \text{Before}) \times 100\ \%$$

Next, these ingredients including peach powder were weighed precisely according to the formulations in Table 3.1 before packed into teabags. The samples were weighed at 2 g and 5 g according to the test requirements by using laboratory analytical digital weighing scale. Based on the formulations, the negative control of this study was Formulation One which does not contain any peach flavour, while the positive control was the commercial peach tea purchased from online store. The amount or percentage of kenaf leaf remained the same which was 60 % of the formulation for each sample. The other ingredients were shuffled to form formulations of peach flavoured kenaf herbal tea. Ginger and lemongrass were also used in this formulation to corporate the taste of the kenaf herbal tea, with addition of peach as flavouring.

Table 3. 1: The formulation of Peach Flavoured Kenaf Herbal Tea.

Formulation	**Ingredient (%)**			
	Kenaf leaf	**Ginger**	**Lemongrass**	**Peach Powder**
F1 (Negative control)	60	20	20	0
F2	60	20	0	20
F3	60	0	20	20
F4	60	10	10	20
F5	60	20	10	10

3.4 Stability Analysis of Peach Flavoured Kenaf Herbal Tea and Control Sample

Two types of packaging were used which were plastic bag with normal sealing, and vacuum pack, where these control and samples were stored indoor in room temperature for one month to evaluate its stability. The stability tests were evaluated on the first day of the teas were packed which was the fresh tea, and on day 30. This test analysed their physical properties which were moisture content, colour, and pH of the teas according to each formulation.

Figure 3. 4: The samples after packed.

The moisture content of each sample was tested by using Moisture Analyser MX-50 from A&D Company, where 5 g of each sample were placed on the machine analyser to be weighed and dried at the temperature of 140 °C for 12 min. The weight of the samples was then weighed again after the drying process and the percentage of the water loss were taken.

Figure 3. 5: Moisture content analysis in Animal Feed Lab, UMK.

Next, for colour and pH testing, each sample were infused in 200 ml of boiling water for exactly 15 min. According to the study by Atalay, D., & Erge, H. S. (2017), the colour of the samples was determined by the colour feature of the samples. The samples were placed on white paper. CIE L*a*b* Chromameter CR-300 were used to determine the colour. For L*, it represents the lightness, where zero (0) value indicated black, 100 indicated white. While a* is the colour indicator, where the positive a* shows red, and negative a* indicates green. Another colour indicator is b* where positive b* shows yellow, and negative b* indicates blue. To analyse the pH, a compact pH meter LAQUAtwin-pH-11 were used. The pH meter was calibrated by using pH4 buffer before analysing the samples and rinsed by distilled water for every test to ensure the accurateness. These samples were tested triplicate.

Figure 3. 6: Samples in 200 ml of boiled water.

3.5 Statistical Analysis of Peach Flavoured Kenaf Herbal Tea and Control Sample

The five formulations and control samples were tested for three times for each test or three replicates. The statistical analysis used was Two-way ANOVA Analysis in IBM Statistical Package for the Social Sciences (SPSS) Statistics software for analysing the pH value and moisture content of the samples. The data acquired was stated as standard deviation (SD). The significance between the peach flavoured kenaf herbal teas and the pH value colour moisture content in each vacuum and plastic packaging were obtained. The p-value under 0.05 indicates there are significant difference. The average mean of the data was also calculated on Microsoft Excel to get the standard deviation (mean ± SEM). The colour was calculated in Nix Sensor Ltd website.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Sample Collection of The Raw Material

The raw ingredients of peach flavoured kenaf herbal tea: kenaf plant, lemongrass, ginger, were harvested from Kenaf Orchard, around UMK, and purchased from the nearest grocery store around UMK. The weight of raw ingredients for the samples were collected during the drying processes in order to get the total crop yield. The drying processing were made in dehydrator machine for 12 hrs at temperature of 50 °C.

Table 4.1.1 showed the data collected and total yield of kenaf plant which were kenaf leaf, kenaf flower and the stem. Based on the table, the initial weight of kenaf leaf was 12,800 g, while after drying was 1107 g, which made the total yield of kenaf leaf was 8.65% after the drying processes. While total yield for kenaf flower and kenaf stem were 13.74% and 15.50% respectively, as the initial weight of kenaf flower was 495 g, and the final weight was 68 g, whereas the initial weight for kenaf stem was 7245 g, and the final weight was 1123 g. Table

4.1.2 showed the data for lemongrass and ginger. For lemongrass, the total yield was 28.17 %, while ginger was 8.24 %. This drying method showed the reduction of moisture content which is reflected by reduced in final weight compared to the initial weight (Mujaffar, S., & John, S., 2018). Therefore, the drying process should be able to inhibit the growth of fungi and in turn will be able to preserve the raw material (van Laarhoven, et al., 2015).

Table 4.1.2 below showed the data collected which were the total yield of lemongrass and ginger. The initial weight of lemongrass was 8768 g, and the final weight was 2470 g. The weight of ginger before drying was 4261 g, and after drying was 351 g which resulting in the total yield of lemongrass and ginger was 28.17 % and 8.24 % respectively. From this data, the total yield of lemongrass was higher than the total yield of ginger

Table 4.1. 1: Total yield of Kenaf Plant

	Kenaf Leaf		**Kenaf Flower**		**Kenaf Stem**	
	Before (g)	**After (g)**	**Before (g)**	**After (g)**	**Before (g)**	**After (g)**
Total	12,800	1107	495	68	7245	1123
Total Yield (%)	8.65		13.74		15.50	

Table 4.1. 2: Total yield of Lemongrass and Ginger

	Lemongrass		Ginger	
	Before (g)	**After (g)**	**Before (g)**	**After (g)**
Total	8768	2470	4261	351
Total Yield (%)	28.17		8.24	

4.2 Stability Analysis of Peach Flavoured Kenaf Herbal Tea and Control Sample

The data of stability analysis were analysed and collected by using Two-way ANOVA in SPSS software. The dependent variable were pH, moisture content, and colour of the samples, while independent variable were two types of packaging, and the formulation. The data were analysed for each test separately. In this stability test, the pH, moisture content, and colour of the samples were analysed.

4.2.1 pH Analysis of Peach Flavoured Kenaf Herbal Tea and Control Sample

Based on the Table 4.2.1.a, the pH value of the samples on day one and day 30 of both packaging showed huge different as it becomes more acidic, compared to the positive control sample which is more stable in pH value. The fluctuation of pH value from the samples might be due to the oxidation process of kenaf leaf during 30 days of storage. To support this suggestion, the colour of the samples on day 30 were darker compared to the colour on day first as shown in Figure 4.2.1.1. As stated by the study from Murugesan, P. et al., (2020), the oxidation process in the tea causing changing in colour where oxidation makes it turned darker. In addition, the catechins found in the tea can cause oxidation and affect the colour of the tea (Matsuo, Y., et al., 2008). Besides, research by Haw, Y. T., Sim, Y. Y., & Nyam, K. L. (2020) showed that kenaf leaf actually contains catechins and high in pH value. In other side, the addition of peach flavour does not affects the pH value although the peach contains low level of citric acid which makes it have the sour taste (Colaric, M., Veberic, R., Stampar, F., & Hudina, M., 2005), as the pH value of negative control sample (F1) which does not contain any peach, showed almost the same value as other samples (F2, F3, F4, and F5).

Table 4.2.1. a: pH Analysis (mean ± SEM) of different formulation between plastic and packaging on Day1 and Day 30.

Formulation	pH Analysis		
	Day 1	**Day 30: Plastic**	**Day 30: Vacuum**
Control	5.1 ± 0.06	5.0 ± 0.06	5.2 ± 0.06
F1	6.8 ± 0.06	3.8 ± 0.00	3.8 ± 0.00
F2	6.9 ± 0.06	3.8 ± 0.06	3.9 ± 0.06
F3	6.8 ± 0.00	3.7 ± 0.00	3.6 ± 0.00
F4	6.8 ± 0.00	3.8 ± 0.00	3.7 ± 0.00
F5	6.8 ± 0.00	3.9 ± 0.06	3.9 ± 0.00

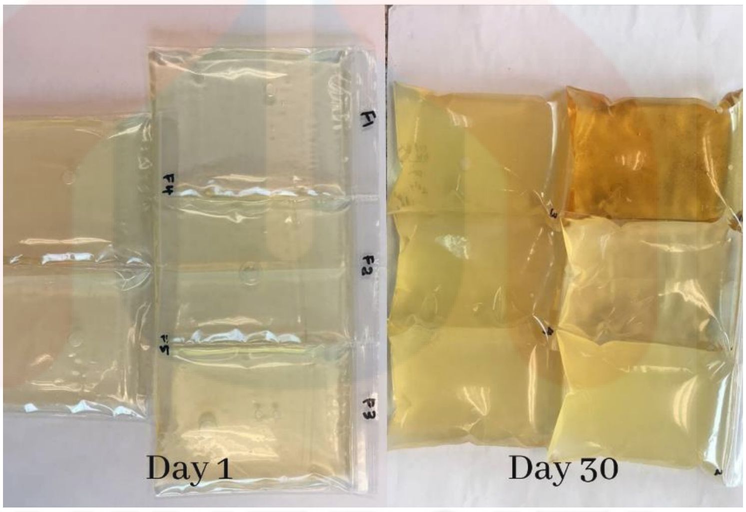

Figure 4.2.1 a: The colour difference of the samples between Day 1 and Day 30.

Based on the Table 4.2.1.b, there were significant difference (P < 0.05) between the pH of each formulation. This showed that each of the formulations were more or less affects the pH value. This might be because of the composition of the ingredients were different, as the mixture of peach, lemongrass, and ginger were in between 0 %, 10 %, and 20 %, causing in inconsistent of pH value between them. The raw ingredient has their own pH which were not the same, as the pH value for lemongrass were around 5.8 to 6.3 which were more alkaline (Mabai, P., Omolola, A., & Jideani, A. I., 2018). While pH value for ginger was 5.60 to 5.90 (FDA/Center for Food Safety & Applied Nutrition., n.d.).

Next, Table 4.2.1.b showed that there were no significant differences (P > 0.05) between the pH of each packaging: normal plastic, and vacuum packaging, and no significant difference (P > 0.05) between the pH of each formulation and packaging: plastic and vacuum. This showed that the type of this two packaging does not practically affects the pH as they showed almost the same value. However, according to the study by Springett, M. B., et al., (1994), packing tea in vacuum packaging will retain the quality of the tea better than commercial tea packaging because vacuum pack removes certain amount of oxygen from the packaging, while normal packaging does not remove any oxygen. Therefore, from this result can be concluded that there were no significant different between the packaging and pH value. In this case, the vacuum pacl does not give significant result. As vacuum pack is very important in removing oxygen, the vacuum pack for this experiment might had some fault, such as the oxygen were not completely removed during the process as the machine were automatic that the intensity to remove oxygen cannot be made. Besides, the sealing might be not complete enough which will cause the oxygen to enter the packaging. In addition, light exposure will also affect the quality of the tea (La Torre, C., et al., 2021, and Lee, J., & Chambers, D. H., 2010).), as the samples were all packed in transparent packaging. Other than that, the tea bag itself were enough to maintain the stability of the samples without the help of the plastic and vacuum packaging.

Table 4.2.1. b: P-value between formulation, packaging, and formulation * packaging for pH value.

Source	P-value
Formulation	0.000
Packaging	0.554
Formulation * Packaging	0.000

Figure 4.2.1.b showed the estimated marginal means of pH value. The figure show that there were huge different of pH value between the positive control sample and the samples of five formulations including the negative control sample, in both types of packaging. This positive control sample was the commercial Peach Oolong tea where it was high in phenolic compound which act as antioxidants which able to preserve the quality of the tea which make it more stable (Davidson, P. M., (n.d.).

In addition, the most stable formulation would be Formulation 5 (F5). This is because F5 showed the least fluctuation among the formulation tested and the nearest value with the positive control sample. Meanwhile, the least stable formulation would be F3. From the result, ginger plays an important role in stabilize as the pH value of the kenaf herbal tea since F3 is the only formulation without ginger. According to Suseno, R. et. al. (2022), ginger contains highest antioxidant compared to its plant group, including lemongrass. Therefore, the antioxidant content in ginger could act as a preservative for the tea.

Furthermore, a comparison between the stability of the packaging shows that vacuum packaging fluctuates higher than plastic packaging among the formulation. However, the fluctuation between vacuum and plastic packaging is not significant.

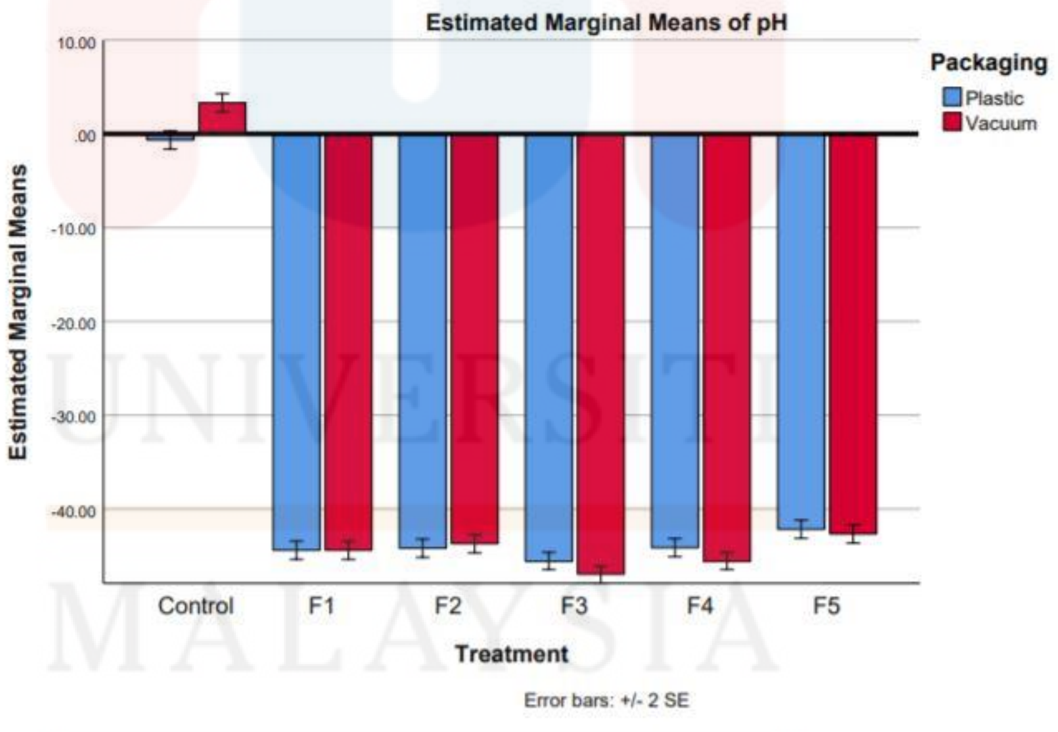

Figure 4.2.1 b: Estimated Marginal Means of pH Value.

4.2.2 Moisture Content

Based on the Table 4.2.2.b, there were no significant difference (P < 0.05) between the moisture content of each formulation. This showed that the formulations were almost the same in term of moisture content value. There were no significant differences (P > 0.05) between the moisture content of each packaging: plastic and vacuum, which means that the moisture content of each packaging was not huge in difference. There was no significant difference between the moisture content of each formulation and packaging: plastic and vacuum. This showed that the formulation in each of the packaging: normal plastic and vacuum pack, were equivalent.

Table 4.2.2. a: P-value between formulation, packaging, and formulation * packaging for moisture content.

Source	**P-value**
Formulation	0.703
Packaging	0.340
Formulation * Packaging	0.109

Based on the Table 4.2.2.a, there were difference in moisture content between the Day 1 and Day 30 of all samples in both packaging where the moisture content was increasing according to time. To compare with the control sample, the least amount of moisture on Day 30 were Formulation Three in vacuum packaging. To support this finding, F3 got the least moisture, followed by F2 in normal plastic packaging. However, the effect of the difference in ingredient were not found and further research had to be done. This is because, the lowest moisture content between normal packaging and vacuum packaging resulted in different formulation: Normal pack (F2), Vacuum pack (F3).

Next, the formulations with high peach flavour showed the least moisture content compared to the formulation with the least peach flavour. This might be because the peach flavour was purchased in powder form, where it contains anti-cacking agent as this ingredient can help in lessen the moisture absorption (Lipasek, R. A., et al., 2012).

However, the least moisture content on Day 30 for control was on normal plastic packaging instead of vacuum packaging. This might be because of the error during handling the experiment such as human error when weighing the ingredient either during packing or analysing moisture content.

Table 4.2.2. b: Moisture Content Analysis (mean ± SEM) of different formulation between plastic and packaging on Day1 and Day 30.

Moisture Content	**Percentage (%)**		
Formulation	**Day 1**	**Day 30: Plastic**	**Day 30: Vacuum**
Control	6.89 ± 1.01	5.87 ± 2.34	7.76 ± 0.48
F1	8.67 ± 0.30	9.13 ± 1.20	9.10 ± 0.24
F2	8.07 ± 0.22	8.43 ± 0.53	8.71 ± 0.15
F3	7.78 ± 0.16	8.82 ± 0.53	8.16 ± 0.18
F4	7.85 ± 0.29	8.63 ± 0.98	8.51 ± 0.10
F5	8.42 ± 0.21	8.93 ± 0.57	8.82 ± 0.19

Based on figure 4.2.2.b, there were huge different of moisture content between the positive control sample and the samples of five formulations including the negative control sample, in both types of packaging. From figure 4.2.2.b suggested that positive control treatment has the highest fluctuation among the sample. This show that positive control treatment has the lowest stability among the sample. From the result, dried peach fruit content in the positive control was lack of stability compared to powder form in the five formulations as it does not contain any additives. In addition, the most stable formulation among these samples would be Formulation 5 (F5). This is because F5 showed the less fluctuation among the formulation tested. Meanwhile, the least stable formulation would be F3.

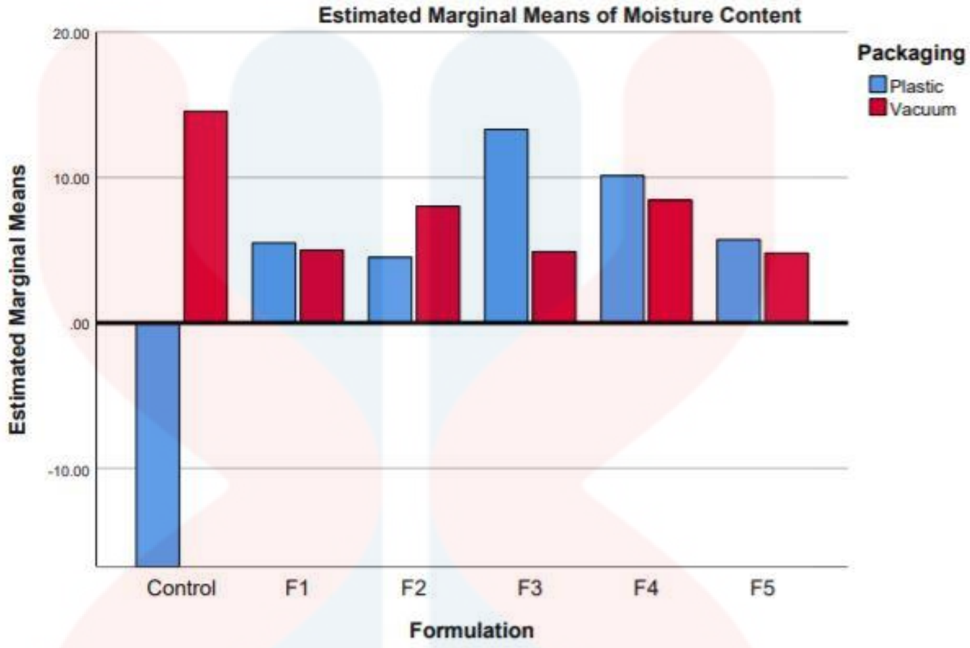

Figure 4.2.2 a: Estimated Marginal Means of Moisture Content.

4.2.3 Colour

In this analysis, the colour was calculated by the colour calculator website by Nix Sensor Ltd. The average mean of L*a*b* were added in the calculator and the colour will appear as shown in Table 4.2.3.b. Based on this figure, the colour of the samples on Day one was lighter than the colour on Day 30 in both normal plastic packaging and vacuum packaging. The darkest colour was on Day 30 in vacuum packaging. This might be due to the oxidation process occurred during storage which caused the darken in colour. However, the dark colour of the samples in vacuum packaging might be resulting from the human error as discussed before. As can be seen by the eye as in Figure 4.2.1.a, the positive control sample were naturally darker than the other five formulations. Therefore, the nearest colour to the positive sample was F2 in vacuum packaging. Based on the study by Smith, R. F., & White, G. W. (1965), the most preferred colour of the tea was orange-red colour as it looks more appetizing and "tea-like" colour. However, further study needs to be made in term of consumer preference towards tea colour.

Table 4.2.3. a: Colour Analysis (mean ± SEM) of different formulation between plastic and packaging on Day1 and Day 30.

Formulation	**Colour Analysis**		
	Day 1	**Day 30: Plastic**	**Day 30: Vacuum**
Control	**L:** 34.35 ± 0.13 **a:** 1.18 ± 0.06 **b:** 10.40 ± 0.19	**L:** 49.03 ± 0.77 **a:** 0.22 ± 0.18 **b:**16.80 ± 0.39	**L:** 31.69 ± 0.12 **a:** 1.76 ± 0.04 **b:** 10.05 ± 0.08
F1	**L:** 50.32 ± 0.26 **a:** -0.11 ± 0.09 **b:** 9.55 ± 0.03	**L:** 39.49 ± 0.35 **a:** 0.13 ± 0.02 **b:** 7.71 ± 0.11	**L:** 34.67 ± 0.96 **a:** 0.05 ± 0.01 **b:** 6.74 ± 0.32
F2	**L:** 41.12 ± 0.25 **a:** 0.26 ± 0.02 **b:** 10.15 ± 0.07	**L:** 41.00 ± 0.05 **a:** 0.17 ± 0.02 **b:** 8.94 ± 0.06	**L:** 29.82 ± 0.22 **a:** 0.46 ± 0.04 **b:** 5.94 ± 0.05
F3	**L:** 40.33 ± 0.22 **a:** 0.35 ± 0.04 **b:** 10.19 ± 0.07	**L:** 38.90 ± 0.45 **a:** 0.45 ± 0.01 **b:** 9.49 ± 0.06	**L:** 31.44 ± 0.08 **a:** 0.49 ± 0.03 **b:** 7.09 ± 0.04
F4	**L:** 43.08 ± 0.96 **a:** 0.52 ± 0.03 **b:** 10.57 ± 0.23	**L:** 30.62 ± 0.21 **a:** 0.33 ± 0.01 **b:** 6.58 ± 0.01	**L:** 33.65 ± 0.12 **a:** 0.41 ± 0.04 **b:** 7.90 ± 0.02
F5	**L:** 45.79 ± 0.61 **a:** 0.31 ± 0.05 **b:** 10.90 ± 0.20	**L:** 36.40 ± 0.23 **a:** 0.15 ± 0.05 **b:** 7,88 ± 0.03	**L:** 35.09 ± 0.03 **a:** 0.15 ± 0.12 **b:** 7.41 ± 0.22

Table 4.2.3. b: The colour analysis from colour calculator by nix Colour Sensor.

Formulation	**Colour Analysis**		
	Day 1	**Day 30: Plastic**	**Day 30: Vacuum**
Control			
F1			
F2			
F3			
F4			
F5			

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

To conclude, the stability of peach flavoured kenaf herbal tea in term of pH value and moisture content were stable. While in term of colour, it needs further study in order to get the best and stable colour, as the colour of the five formulations were light compared to the positive control (oolong tea). While for packaging which were normal plastic pack and vacuum pack, the other findings showed an excellent result in vacuum packaging in term of retaining the quality of food product, while this study showed there were almost similar result in stability test: pH value, moisture content, and colour, between both packaging. This showed that the tea bag was enough to maintain the quality of the teas in these experiments, without addition of outer packaging, in term of stability test. In addition, the overall best formulation was the F3 while comparing to the positive control, although between it still have quite different in analysis which might be due to the different main ingredient of the teas.

5.1 Recommendation

As a final point, there are a few recommendations to complete this research for future work. First, more types of flavour might help to find out the better consumer preference in term of taste, alongside with the sensory evaluation analysis. Different types of flavour physical characteristic also might help in obtaining the best formulation, such as a study between the extraction of the flavour, and the powdered version of the flavour.

Furthermore, some of the studies suggested that the packaging of the tea might influence the quality, together with the presence of light during storage due to transparent packaging influence the tea. Therefore, study regarding this matter might help in making better packaging for flavoured kenaf herbal tea.

In the final analysis, adding some antioxidant ingredients or preservatives such as ascorbic acid might help in retaining the quality of the tea (Murugesan, P., et al., 2020) as this might help in formulating better flavoured kenaf herbal tea.

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APPENDICES A

Table A. 1: Descriptive Statistics of pH Value.

Descriptive Statistics

Dependent Variable: pH

Treatment	Packaging	Mean	Std. Deviation	N
Control	Plastic	-.6533	1.13161	3
	Vacuum	3.3067	2.33250	3
	Total	1.3267	2.71899	6
F1	Plastic	-44.3900	.46765	3
	Vacuum	-44.3900	.46765	3
	Total	-44.3900	.41828	6
F2	Plastic	-44.1767	.72666	3
	Vacuum	-43.6933	.36950	3
	Total	-43.9350	.57958	6
F3	Plastic	-45.5900	.00000	3
	Vacuum	-47.0600	.00000	3
	Total	-46.3250	.80515	6
F4	Plastic	-44.1200	.00000	3
	Vacuum	-45.5900	.00000	3
	Total	-44.8550	.80515	6
F5	Plastic	-42.1600	.84870	3
	Vacuum	-42.6500	.00000	3
	Total	-42.4050	.60012	6
Total	Plastic	-36.8483	16.69800	18
	Vacuum	-36.6794	18.47511	18
	Total	-36.7639	17.35582	36

Table A. 2: Test of Between-Subjects Effects (pH Value)

Tests of Between-Subjects Effects

Dependent Variable: pH

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10525.771[a]	11	956.888	1344.049	.000
Intercept	48657.007	1	48657.007	68343.826	.000
Formulation	10495.055	5	2099.011	2948.279	.000
Packaging	.257	1	.257	.361	.554
Formulation * Packaging	30.459	5	6.092	8.557	.000
Error	17.087	24	.712		
Total	59199.865	36			
Corrected Total	10542.858	35			

Table A. 3: Descriptive Statistics of Moisture Content Value.

Descriptive Statistics

Dependent Variable: Moisture Content

Formulation	Packaging	Mean	Std. Deviation	N
Control	Plastic	-16.8000	25.35572	3
	Vacuum	14.5567	21.45628	3
	Total	-1.1217	27.13459	6
F1	Plastic	5.5033	15.34841	3
	Vacuum	5.0067	3.07965	3
	Total	5.2550	9.90440	6
F2	Plastic	4.5033	4.41797	3
	Vacuum	8.0233	4.88258	3
	Total	6.2633	4.58916	6
F3	Plastic	13.3067	5.91211	3
	Vacuum	4.8967	3.11861	3
	Total	9.1017	6.25219	6
F4	Plastic	10.1200	14.22251	3
	Vacuum	8.4333	4.76718	3
	Total	9.2767	9.53183	6
F5	Plastic	5.7267	7.26940	3
	Vacuum	4.8000	3.74301	3
	Total	5.2633	5.19609	6
Total	Plastic	3.7267	15.45663	18
	Vacuum	7.6194	8.72365	18
	Total	5.6731	12.52603	36

Table A. 4: Test of Between-Subjects Effects (Moisture Content)

Tests of Between-Subjects Effects

Dependent Variable: Moisture Content

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2035.068[a]	11	185.006	1.285	.291
Intercept	1158.608	1	1158.608	8.045	.009
Formulation	429.604	5	85.921	.597	.703
Packaging	136.383	1	136.383	.947	.340
Formulation * Packaging	1469.080	5	293.816	2.040	.109
Error	3456.479	24	144.020		
Total	6650.156	36			
Corrected Total	5491.548	35			

APPENDICES B

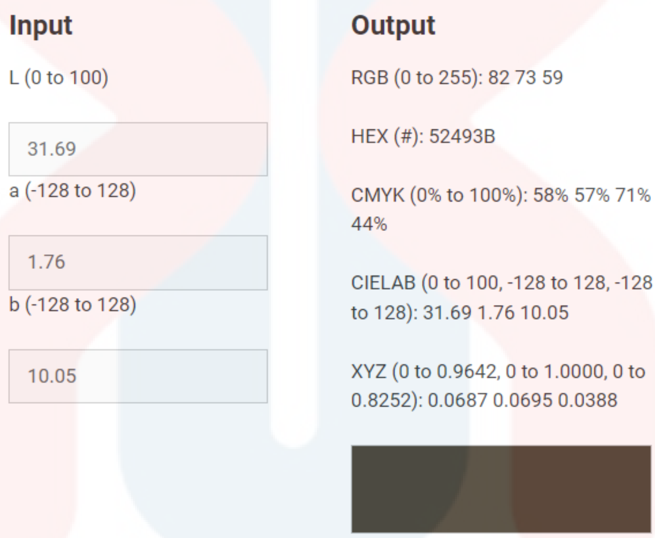

Figure B. 1: Colour Calculation Control Day 30 Plastic

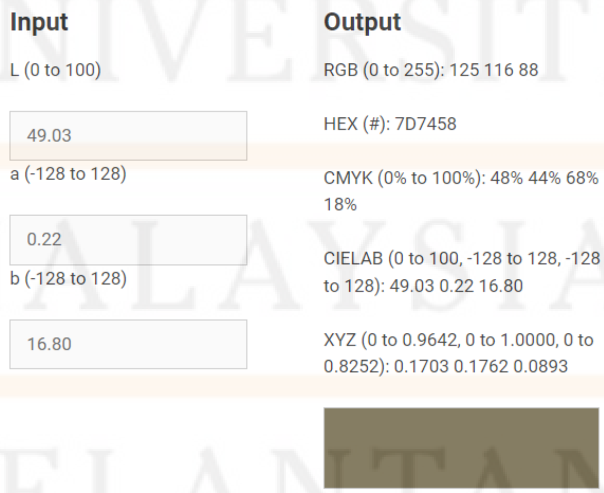

Figure B. 2: Colour Calculation Control Day 30 Vacuum

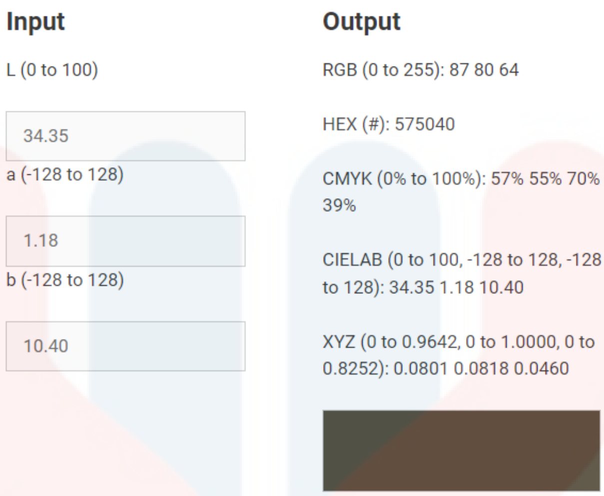

Figure B. 3: Colour Calculation Control Day 1

Figure B. 4: Samples in teabags.

Figure B. 5: Food Processor.

Figure B. 6: pH Compact Meter.

Figure B. 7: Colourimeter Machine.

Figure B. 8: Vacuum and sealer machine.

Figure B. 9: Drying kenaf leaves in dehydrator.

Figure B. 10: Weighing kenaf stalks.

Figure B. 11: Sample Day 1 in boiling water.

Figure B. 12: Colour analysing.

Figure B. 13: Packing peach flavoured kenaf herbal tea into teabag.

Figure B. 14: Kenaf leaves preparation.

Figure B. 15: Kenaf Orchard, Bukit Bunga