Physicochemical and Sensory Evaluation of Snack Made with *Parkia speciosa* (Stink Bean)

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DECLARATION

I hereby declare that the work embodied in this report is the result of the original research and has not been submitted for higher degree to any universities or institutions.

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I certify that the report of this final year project entitled "**Physicochemical and Sensory Evaluation of Snack Made with *Parkia speciosa* (Stink Bean)"** by Saranya Muthu, metric number F18B0315 has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Product Development Technology) with Honours, Faculty of Agro-Based Industry, Universiti Malaysia Kelantan.

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ABSTRACT

Because of the population's changing lifestyle nowadays, there has been a significant increase in fast foods and snacks consumption. People nowadays are expecting ready-to-eat food. Snacks were one of the ready-to-eat food. Snacks are an essential part of many people's daily nutrient and calorie intake. At the same time, consumers are expecting new flavor of snacks to consume. *Parkia speciosa*, also known as bitter beans, stink bean, or well known as "petai" among Malaysians, is usually served with dried sambal, chili peppers, red onions, and shrimps paste. Hence, this study aims to develop a snack made of *P. speciosa*. In this study, *P. speciosa* snacks were evaluated at different proportions (60%, 40%, and 20%). Snack prepared without *P. speciosa* was served as control. Physicochemical properties such as determination of colour and texture analyses ash, moisture, protein, and lipid, were analysed using the standard method. Results showed the moisture content of *P. speciosa* snack were ranged from 3.83% to 1.76%, ash ranged from 4.34% to 2.47% and protein ranged from 3.08% to 1.45%. The fat content varied from 63.89% to 88.7%, with the control having the highest fat level. On the other hand, the colour value of *P. speciosa* snacks showed significant changes when the amount of *P. speciosa* was decreased. As regard to sensory properties, formulation 2 snack had better acceptability. However, *P. speciosa* snack had higher nutritional value. Based on the results, novel *P. speciosa* snacks have been accepted by consumers.

Key words: *Parkia speciosa*, physicochemical, sensory evaluation, development of snack, nutritional fact, flavour

ABSTRAK

Oleh kerana perubahan gaya hidup penduduk pada masa kini, terdapat peningkatan yang ketara dalam penggunaan makanan segera dan makanan ringan. Orang ramai pada masa kini mengharapkan makanan sedia untuk dimakan. Makanan ringan adalah salah satu makanan yang sedia untuk dimakan. Makanan ringan adalah bahagian penting dalam pengambilan nutrien dan kalori harian ramai orang. Pada masa yang sama, pengguna menjangkakan rasa baru makanan ringan untuk dimakan. *Parkia speciosa*, juga dikenali sebagai kacang pahit, kacang busuk, atau dikenali sebagai "petai" dalam kalangan rakyat Malaysia, biasanya dihidangkan bersama sambal kering, lada cili, bawang merah dan pes udang. Oleh itu, kajian ini bertujuan untuk membangunkan makanan ringan yang diperbuat daripada *P. speciosa*. Dalam kajian ini, snek *P. speciosa* dinilai pada perkadaran yang berbeza (60%, 40%, dan 20%). Snek yang disediakan tanpa *P. speciosa* dihidangkan sebagai kawalan. Sifat fizikokimia seperti penentuan warna dan analisis tekstur abu, lembapan, protein, dan lipid, dianalisis menggunakan kaedah piawai. Keputusan menunjukkan kandungan lembapan snek *P. speciosa* adalah antara 3.83% hingga 1.76%, abu antara 4.34% hingga 2.47% dan protein antara 3.08% hingga 1.45%. Bagi kandungan lemak, ini adalah antara 63.89% hingga 88.7%, di mana kawalan mempunyai lemak paling tinggi. Sebaliknya, nilai warna snek *P. speciosa* menunjukkan perubahan ketara apabila jumlah *P. speciosa* berkurangan. Berkenaan dengan sifat deria, snek formulasi 2 mempunyai kebolehterimaan yang lebih baik. Walau bagaimanapun, snek *P. speciosa* mempunyai nilai pemakanan yang lebih tinggi. Berdasarkan keputusan, snek novel *P. speciosa* telah diterima oleh pengguna.

Kata kunci: *Parkia speciosa*, fizikokimia, penilaian deria, perkembangan makanan ringan, fakta pemakanan, rasa

TABLE OF CONTENT

DECLARATION	**I**
ACKNOWLEDGEMENT	**II**
ABSTRACT	**III**
ABSTRAK	**IV**
TABLE OF CONTENT	**V**
LIST OF TABLES	**IX**
LIST OF FIGURES	**X**
LIST OF SYMBOLS AND ABBEVIATIONS	**XI**
CHAPTER 1 INTRODUCTION	**1**
1.1 Research Background	1
1.2 Problem Statement	3
1.3 Hypothesis	5
1.4 Scope of Study	5
1.5 Significant of Study	6
1.6 Objectives	6

1.7 Limitation of Study 6

CHAPTER 2 LITERATURE REVIEW 7

2.1 Underutilized Legume 7

2.2 *Parkia speciosa* Hassk 8

2.3 Classification of *Parkia species* 9

2.4 Nutritional Values of *Parkia speciosa* 9

2.5 Snack Food 10

2.6 Snack Food made off with *Parkia speciosa* 10

2.6.1 Potato Flour 10

2.6.2 Low Protein Flour 11

2.6.3 Margarine Fat/Oil 12

2.6.4 Egg 13

2.6.5 Baking Powder Leavening Agent 13

2.6.6 Salt 14

2.6.7 Cashew Nuts 14

2.7 Nutritional Composition of *Parkia speciosa* Snack 15

2.7.1 Physicochemical Analysis 15

2.7.2 Proximate Analysis 17

2.7.3 Sensory Evaluation 18

CHAPTER 3 MATERIALS AND METHODS 20

3.1 Materials 20

3.1.1 Chemical and Reagents 20

3.1.2 Equipment 20

3.1.3 Raw Materials 21

3.2 Methods 21

3.2.1 Experimental Design 21

3.2.2 Preparation of *P. speciosa* Snack 22

3.3 Physicochemical Analysis 23

3.3.1 Colour Analysis 23

3.3.2 Texture Analysis 24

3.4 Proximate Analysis 24

3.4.1 Ash Content 24

3.4.2 Moisture Content 25

3.4.3 Protein Content 26

3.4.4 Lipid Content 27

3.5 Sensory Evaluation 28

3.6 Statistical Analysis 29

CHAPTER 4 RESULTS AND DISCUSSION 30

4.1 Production of *Parkia speciosa* Snack 30

4.2 Physicochemical Properties of *Parkia speciosa* Snack 31

4.2.1 Colour Analysis 31

4.2.2 Texture Analysis 35

4.3 Proximate Analysis 37

4.4 Ash Content Determination in *Parkia speciosa* Snack 37

4.5 Moisture Content Determination in *Parkia speciosa* Snack 38

4.6 Protein Content Determination in *Parkia speciosa* Snack 39

4.7 Fat Content Determination in *Parkia speciosa* Snack 40

4.4 Sensory Evaluation 42

CHAPTER 5 CONCLUSION AND RECOMMENDATION 46

5.1 Conclusion 46

5.2 Recommendation 47

REFERENCES 48

APPRENDIX 53

LIST OF TABLES

		PAGES
3.2	Three different formulations of *Parkia speciosa* Snack	20
4.2	Least significant difference test on colour coordinates tested on *P. speciosa* snack	30
4.3	Effect of different formulation on textural parameters in *P. speciosa* snack	31
4.4	Total ash content in *Parkia speciosa* snack	33
4.5	Moisture Content in *Parkia speciosa* Snack	34
4.6	Protein Content in *Parkia speciosa* Snack	35
4.7	Fat Content in *Parkia speciosa* Snack	37
4.8	Sensory attributes of *Parkia speciosa* snack	38

LIST OF FIGURES

		PAGES
2.1	Seeds and pods of *Parkia speciosa*	6
4.1	*Parkia speciosa* snack	27
4.2	Colour changes in Formulation 1	29
4.3	Colour changes in Formulation 2	29
4.4	Colour changes in Formulation 3	29

LIST OF SYMBOLS AND ABBREVIATIONS

%	Percentage
±	Plus-minus
N	Sample size
mL	Millilitre
a*	Redness/greenness
L*	Lightness
b*	Blueness/yellowness
ºC	Degree Celsius
g	Gram
≤	Inequality
p	*p*-value
et.al	and others
ANOVA	Analysis of Variance
SPSS	Statistical Package for the Social Science

CHAPTER 1

INTRODUCTION

1.1 Research Background

Due to the population's changing lifestyle, there has been a significant increase in fast food and snack consumption in this era. Thus, consumers wish to have fast, and straightforward packaged foods and the convenience of purchasing pre-prepared, frozen, and ready-to-use items on the market. Among these products, snacks are described as small meals with light or substantial nutritional value and linked to the sensory attributes "healthy" (Netto et al., 2014). Besides, particularly in urban towns, snacks are becoming popular because most people now work far from home. Furthermore, a snack is a small amount of food consumed between meals smaller than a daily meal. Snacks are available in several ways, including canned and other processed foods prepared at home with fresh ingredients. Snack foods are generally made to be compact, simple, and filling. Snacks are an essential part of many people's daily nutrient and calorie intake (Mangaraj et al., 2018).

Malaysia has diverse valuable and useful food crops as a tropical country. In different food applications, many plant resources can be used. While Malaysia has many kinds of legumes, only a few are widely known as commercial food crops. According to a study, many other indigenous legumes are frequently overlooked and underutilized for their potential to serve as alternative legume sources for locals and use in food applications (Cheng and Rajeev Bhat, 2015). Neglected or undervalued legumes are also known as underutilized legumes. According to Bhat and Karim (2009), underutilized legumes have poor market value. They are commonly limited to a more local consumption pattern. Hence, most plants and their derivatives have historically been used for medical purpose. These plant products can include tubers, seeds, stem, and many more. However, according to Cheng and Rajeev (2015), legumes and seeds make up a substantial amount and contribute considerably as a critical source of nutrients for humans and animals. Compared to cereal grains, most legumes are high in nutrients, particularly protein (18-24%) (Noor Aziah et al., 2012).

For resistance, *Parkia speciosa* is one of the underutilized legumes in Malaysia. *P. speciosa* seeds are commonly used in cooking. The seeds are also used in traditional medicine to cleanse and detoxify the kidneys and urinary tract and treat diabetes and headaches. It's also used to treat itchiness, inflammation, edema, liver failure, and get rid of intestinal worms (Nurul Izzah et al., 2019).

Parkia speciosa, also known as stink bean, is commonly grown and cultivated in Southern Asia, including Malaysia, Indonesia, the Philippines, and North-Eastern India (Ahmad at al., 2019). It is a plant of the Fabaceae family, belonging to the genus *Parkia* and species *speciosa* (also placed in Leguminosae and Mimosaceae) (Yusof et al., 2013). In Malaysia, Singapore, and Indonesia, *P. speciosa* is also known as ‘petai’, while in Thailand as ‘sator’ or ‘sataw’, in the Philippines as 'u'pang,' and in India as ‘yongchak’. Because of its strong and pungent smell, *P. speciosa* became a ‘stink bean’ (Nur, 2019). Moreover, the *P. speciosa* fruits are long and greenish. Usually, the seeds are in pods, approximately 35 - 45 cm long and 3 – 5 cm wide. Because of their high nutritional value, the seeds have been consumed as either cooked or raw (Mohd Azizi et al., 2008). However, *P. speciosa* seed can be eaten as raw as ‘ulam’ (a Malaysian word known as uncooked) or cooked.

P. speciosa, also known as bitter beans, stink bean, or ‘petai’, is usually served with dried sambal, chili peppers, red onions, and shrimp paste. The study aims to study the physicochemical and sensory evaluations of developed snacks made from *P. speciosa* bean. Besides potato flour, low-protein flour, *P. speciosa* (stink bean), margarine, egg, salt, and baking powder are necessary for *P. speciosa* snack.

1.2 Problem Statement

As a result of urbanization and modernization, snack food intake has increased. However, most snacks contain a high level of fats, sugar, salts, and a low dietary fiber, leading to health issues (Williams, 2009). Usually, when it comes to snacks, everyone’s thoughts would snack are unhealthy. Few preservatives are added to the unhealthy snacks to kids nowadays. However, local populations have become overly reliant on carbohydrate-rich diets in recent years, especially in developing countries. Besides that, demand for healthy and conventional foods has risen in most of the world's regions. Nowadays, developing novel food products using local plant resources such as legumes and seeds is important (Cheng and Rajeev, 2015).

Moreover, Malaysia is a tropical country with many valuable and practical food crops. Many plant resources can be used in a variety of food applications. Although Malaysia has many legumes, only a few are well-known and widely consumed as commercial food crops. In terms of that, *P. speciosa* is one of the legumes often neglected and underexplored by the consumer. Therefore, *P. speciosa*, also known as ‘petai’, is a well-known vegetable, but no downstream product is produced from this vegetable. To make a healthy snack and make *P. speciosa* notable to all consumers, this research develops a snack made from *P. speciosa*. Although *P. speciosa* can be served with a variety of dishes, consumer acceptance towards the taste and smell of *P. speciosa* in snack forms is the major concern of this study

Besides, consumer acceptance towards *P. speciosa* snack would be a concern in this study whether all age groups will accept it in terms of aroma, texture, taste, and crunchiness. Meanwhile, since there are three different types of formulations, it is doubted that it could change the quality of the snack. Therefore, this study aims to measure sensory parameters in terms of texture, crunchiness, aroma, taste, and overall acceptance towards *P. speciosa* snack.

1.3 Hypothesis

H_O: Different types of *P. speciosa* snack formulations were not significantly different in term of physicochemical, color, and sensory.

H_1: Different types of *P. speciosa* snack formulations were significantly different in term of physicochemical, color, and sensory.

1.4 Scope of Study

Legumes are high in nutrients, particularly protein (much higher than cereals), fiber, minerals, and essential vitamins. As a result, legumes are ranked second in importance to cereals as a source of human nutrition (Bhat and Karim, 2009). Legumes are usually coming from the Fabaceae family. Furthermore, daily intake of legumes has been linked to a lower risk of chronic diseases (Bhat and Karim, 2009). *Parkia speciosa* is one of the legumes from Fabaceae family. Hence, this study delivers a snack made from *P. speciosa* with some basic ingredients. Besides, this snack has three different formulations, and these formulations were used to determine physicochemical properties (moisture, ash, lipid, protein, colour analyzer, and textural analyzer). Lastly, this study was also to perform sensory evaluation pf *P. speciosa* snack. The parameters include aroma, colour, taste, crunchiness and overall acceptability.

1.5 Significant of Study

Due to the pungent smell of *P. speciosa*, not many people are desire to consume *P. speciosa*. But people preferred a unique flavour that was processed into a new product. In terms of that, this study is to develop a healthy snack made off with *P. speciosa*. This snack can be consumed by children who are hate to eat vegetables. Also, since *P. speciosa* naturally contains a high nutritional value, it can be consumed by all ages.

1.6 Objectives

The objectives of this study were as follows:

1. To develop snack from *P. speciosa* using three different formulations of blended *P. speciosa*.
2. To determine the physicochemical properties of three different formulations of snack *P. speciosa*.
3. To determine the sensory properties of *P. speciosa* snack.

1.7 Limitation of Study

In this study, there were some limitations due to some factors. There is a lack of journals and articles regarding *P. speciosa* snacks. Due to that, it isn't easy to extract information regarding the snack made of *P. speciosa*.

CHAPTER 2

LITERATURE REVIEW

2.1 Underutilized Legume

The term “legume” crops include all crops in the pea and bean family (Fabaceae), which is divided into three subfamilies (Papilionaceae, Mimosaceae, and Caesalpinaceae) and are rich in high-quality protein, having a significant impact on the nutrition, diet, and health of many people around the world (Popoola et al., 2019). The importance of legumes as food crops is ranked second only after cereals. According to research, they are an excellent source of plant proteins and minerals for both human and animal nutrition (Cheng & Bhat, 2015). Moreover, underutilized legumes are also known as neglected or undervalued legumes. According to Cheng & Bhat (2015), the market value and production volume of underutilized legumes are low. They usually are limited to a more localized consumption pattern.

Malaysia is a tropical country rich in various important and valuable food crops. Numerous plant resources could be employed in various food applications. Although there are many different types of legumes in Malaysia, just a few are well-known and frequently consumed as commercial food crops (Cheng & Bhat, 2015). For example, popular legumes in the local market include chickpea, soybean and petai. Many indigenous legumes are frequently overlooked and underutilized for their potential to serve alternate legume sourced for people and usage in food applications.

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2.2 *Parkia speciosa* Hassk

Parkia speciosa, also known as "petai" among Malaysians, is a rainforest tree that can reach a height of 40 meters and a diameter of 100 centimeters. Malaysia, Indonesia, Thailand, and the Philippines are all home to this tree. According to Abdullah et al. (2011), it starts to bear fruit after about seven years of planting. The tree contains flowers in light bulbs hung from the end of long stalks. After maturation, a cluster of long, twisted pods emerges at the end of each tree. Besides, the flower is creamy white and has a long stalk that measures 30–45 cm in length and 2–6 cm in width and has a leathery texture. Long and twisted pods emerge from the stalk's border when the plant matures. The fruit consists of an oblong pod, 35–55 cm long and 3–5 cm wide, with 15–18 seeds. Seeds are 3.5 cm long and 2 cm wide when mature, and they grow in size and have a round shape (Navnidhi et al., 2018).

The seeds (Figure 2.1) are very popular with local people and often used to prepare traditional local delicacies. To enhance their flavor, they can be eaten raw or cooked using local spices, like garlic, chili pepper, and dried shrimp. Seeds are traditionally used to treat diabetes, kidney pain, and cholera (Abdullah et al., 2011).

Figure 2.1: Seeds and pods of *Parkia speciosa*

2.3 Classification of *Parkia species*

The genus *Parkia* is divided into three groups: *Parkia*, *Platyparkia*, and *Sphaeroparkia*. The three parts are distinguished by the clear variations in the flower forming configuration (Navnidhi et al., 2018). *Parkia speciosa* was used in this experiment which is also known as 'petai papan' among Malaysians. The seed of *P. speciosa* or "petai papan" is quite bigger compared to another two species. Also, it is not seasonal planted and easy to get on the market.

2.4 Nutritional Values of *Parkia speciosa*

P. speciosa seed contains various nutritional levels, including protein, fat, carbohydrate, and a good mineral source. The seeds have a significant amount of α-tocopherol (Vitamin E) and vitamin C. According to Yusof et al. (2013), *P. speciosa* seeds had the highest thiamin (vitamin B1) content but a negligible antithiamine factor. High tannin levels compared to other fruit vegetables were detected on its seed coats and pods.

The seeds are also rich in essential or non-essential bioactive compounds from secondary metabolites with extensive therapeutic advantages (Nurul et al., 2019).

2.5 Snack Food

Snacks have become one of the most common and well-accepted food items in the world today, appealing to people of all ages. Snack chips are a good energy source and "ready to eat." Furthermore, snack chips can be produced in large quantities in a short period, allowing for widespread distribution (Cheng and Rajeev, 2015). A snack is often less than a regular meal, which is usually eaten between meals. Various snacks are available, including packaged and processed food and fresh ingredients made at home. Basically, for many consumers, snacks provide essential components of daily nutrients and calories.

2.6 Snack Food made off with *Parkia speciosa*

2.6.1 Potato Flour

Potato is one of the most widely consumed food globally since it is simple to cook and can be eaten as a staple meal, healthy vegetable, or snack food. Thus, potatoes can be used to make a wide range of items. The most popular potato processed items are chips and French fries. Meanwhile, potato is a widely viable starch source for industrial application. Potato starch has unique properties that make it ideal for use in food. The processing of potatoes into flour is the best method of creating a functionally adequate product and remains safe for a long time (Ramesh & Rakesh, 2009).

Processed potato products, especially potato flour, are highly versatile in producing convenience foods. Since it is rich in starch, the functional properties of several food products can be improved by potato flour. It is possible to use in numerous foods. It has its distinct flavour and texture but is bland enough to quickly integrate into typical local dishes (Karuna, 1996). Besides, few products can be prepared by combining potato flour with other flour processed in various ways, including baking, roasting, steaming, boiling, and deep fat frying. Moreover, to preserve the freshness of bread, potato flour is added. It also adds a distinct, pleasing flavour and improves baking qualities, making it useful in crackers, pastries, yeast-raised doughnuts, cakes, and cake mixes (Ramesh & Rakesh, 2009).

Besides that, potato flour has a high concentration of essential nutrients such as protein, fiber, and carbohydrates. It has a higher protein content than cassava and yam flour and is comparable to rice. Fiber amounts in potato flour are higher than refined wheat flour, maize meal, or rice (Ramesh & Rakesh, 2009).

2.6.2 Low Protein Flour

Low protein flour is also known as cake flour. Besides, it is also well known for raising flour and phosphate flour. It is a low-protein flour that contains salt and leavening (baking powder). Cake flour made from soft wheat and self-rising flour is an example of low-protein flours. The best cakes are made with low-protein flour (7-9%) to produce soft and fluffy cakes. It's almost called soft flour because it's made entirely of endosperm with small particles and some starch harm.

Moreover, cake flour has a low ash and protein content and is produced for the best cake quality through milling technology of soft and hard wheat that is free of bran and wheat germ. Soft wheat flour is typically a weak flour with low water absorption. When working with a batter or a dough system, no strong mixing or long mixing time is required because the resulting products have qualities such as tenderness, softness, crispness, and good texture (Hanee, 2013).

2.6.3 Margarine Fat/Oil

Fat is an important component in making *P. speciosa* snacks. The type of fat utilized in a snack is margarine. Margarine is the type of fat used to prepare *P. speciosa* snacks. Fat aims to impart aroma, soften the dough, and increase nutrient content. Raquel et al. (2014) said that fats and oils play an essential role in many foods. Fats impart flavour to foods and influence how flavour components are released when they are consumed, as well as providing lubrication and a feeling of moistness in the mouth (Vallerio at al., 2014). They also add flavour to foods and help establish texture by aerating batter.

2.6.4 Egg

Chicken eggs were used in the making of *P. speciosa* snacks. Eggs play a significant role in foods, including baked goods. Such functions include enhancing color, contributing to the structure, emulsifying, and acting as a thickener agent. Other than that, egg constituents can act as moisturizing, emulsifying, and gel network agents in foodstuffs and therefore contribute to developing their unique sensory and rheological features (Samson et al., 2017). Meanwhile, the egg was used as a binding agent to bind the ingredients.

2.6.5 Baking Powder Leavening Agent

The baked powder offers one single product with a whole leavening mechanism. It comprises of sodium bicarbonate, one or more leavening acids, and a diluent, usually starch or calcium carbonate (Niza et al., 2019). Baking powder was used to raise the dough. Baking powder aims to help the dough rise and keep the snack fresh. Baking powder is also the product of an acid reaction involving sodium bicarbonate. Baking powder's purpose is to ensure that the dough rises properly and stays in good shape.

2.6.6 Salt

The purpose of using salt is to give a savory taste to the *P. speciosa* snack dough. Salt is a unique food ingredient (sodium chloride, NaCl) widely used at home, food service, and food processing. Salt is essential for life, and saltiness is one of the most common human tastes. Salt is one of the most ancient and widely used food seasonings, and salting is an effective food preservation technique. In the production of *P. speciosa* snack, salt was used as a preservative and seasoning to enhance the taste of the snack.

2.6.7 Cashew Nuts

Cashews are the dried or roasted fruits of the cashew tree (*Anacardium occidentale*), which produce cashew nuts (also known as Cashews) (Dias et al., 2019). Also, Cashew nuts can be eaten raw or roasted, or processed into food by-products. They have a soft, slightly sweet flavour and are notable for their high lipid content (Dias et al., 2019). Cashews can be eaten as snacks, roasted and salted nuts alone or in combination with other nuts, or used in recipes, or processed into different products such as cashew milk, cashew cheese, or cashew butter, which are nutritionally rich and low in calories when compared to soy and dairy milk (Tola & Mazengia 2019).

2.7 Nutritional Composition of *Parkia speciosa* Snack

This study is aimed to develop snack from *Parkia speciosa* using basic ingredients and to analyse the physicochemical and nutrition contents of the snack. The proximate analysis is to determine the total amount of moisture content, ash content, protein, fat and carbohydrate. Meanwhile, physicochemical analysis determines the colour and texture of *P. speciosa* snack.

2.7.1 Physicochemical Analysis

2.7.1.1 Colour Properties

One of the most important sensory quality attributes of fresh and processed foods, products, and marketing is appearance. The term includes size, form, texture, mass, gloss, and colour (Pankaj et al., 2012). Hence, colour is an important quality attribute of food products that influences consumer preference. According to Pankaj et al. (2012), the first sensation that the user perceives and uses to accept or reject food is the appearance of the food, which is primarily determined by surface colour. Besides, the visual appearance of the product and its colour have a significant impact on a consumer's perception of the food's quality. Furthermore, colour is a significant sensory attribute that gives fundamental quality information for human perception, and it is closely related to quality aspects such as freshness, maturity, variety and appeal, and food safety, making it an important grading criterion for most food products (Wu and Wen Sun, 2013).

Moreover, traditional instruments such as colorimeters have been used extensively in food industries to determine the colour properties of food products. Colourimeters, such as the Minolta chromameter, the Hunter Lab colourimeter, and the Dr. Lange colourimeter, are used to assess the colour of primary radiation sources that emit light and secondary radiation sources that reflect or transmit light (Wu and Wen Sun, 2013). Hence, this instruments' measurement is simple and rapid.

2.7.1.2 Texture Profile Analysis

Textural parameters of foods, whether taken by the hands, or in the mouth and chewed, are experienced with the sense of touch. A textural analysis is an important aspect for quality control and determining the taste of specific food products. It also determines the chewability index of the products. The textural properties of the product entice the consumer to taste it repeatedly. Therefore, Texture Profile Analysis (TPA) is a test to objectively measure texture parameters originally developed at the General Foods Corporation (1963). Moreover, texture analysis is primarily used to assess the product's pre- and post-quality. Hardness, crispiness, crunchiness, softness, springiness, tackiness, and other food properties are measured using standard tests such as compression, tension, and flexibility (Srilakshmi, 2020).

2.7.2 Proximate Analysis

2.7.2.1 Ash Content

Determining ash content in food is part of proximate analysis for nutritional evaluation. The analysis of ash content in foods simply removes organic content to reveal inorganic minerals. This aids in determining the amount and form of minerals in food, which is important because mineral content can affect the physicochemical properties of foods and microorganism development (Dairy, 2010).

2.7.2.2 Moisture Content

In the processing and testing food products, moisture determination is an essential and commonly used analytical measurement. Besides, the taste, texture, stability, and appearance of foods depend on the water they contain (John et al., 2018). Moisture content is an indicator of food solids' yield and quantity, and it's often used as an index of a product's economic value, stability, and efficiency. As a result, it is significant for the food industry.

2.7.2.3 Protein Content

Proteins are a good source of energy. Furthermore, proteins are major structural elements of many natural foods and can affect food products' texture, appearance or stability. In order to satisfy labeling criteria for food quality controls, it is essential to establish methods for analyzing the identification, concentration, structure, and functional properties of proteins in foods (Maria Hayes, 2020).

2.7.2.4 Lipid Content

Crude fat is a major part of the composition in nutrient composition. Lipids contribute to various desirable food characteristics, including texture, structure, mouthfeel, flavour, and colour. In general, food quality is closely linked to lipid quality (Domenico et al., 2018). Domenico et al. (2018) reported that the main causes of food quality loss are degradability and lipid alteration. Thus, this is why several researchers have investigated to see whether it was possible to prevent or slow down modification processes or change the native composition of foods by fortifying them with certain lipid groups that have health benefits.

2.7.3 Sensory Evaluation

Sensory is to conducted to ensure consumer acceptance towards the product. In addition, sensory evaluation is a technique for accurately measuring human responses to food and minimizing the potentially biasing effects of brand identity and other information influences on consumer perception. Even so, it attempts to isolate the sensory properties of food themselves and provides useful and important information about the sensory characteristics of the products to the product developers (Lawless and Heymann, 2010). In term of taste, aroma, texture and overall acceptance. Moreover, according to Lawless and Heymann 2010., sensory evaluation can be defined as the scientific method for gathering information, measuring, analysing and interpreting responses to products as perceived through the sense of sight, smell, touch, taste and hearing.

CHAPTER 3

MATERIALS AND METHODS

3.1 Materials

3.1.1 Chemical and Reagents

The chemicals used for further analysis are sodium hydroxide, 0.1M hydrochloric acid, boric acid (4%), and catalyst tablets for protein analysis. Meanwhile, the utilized chemical was petroleum ether to determine fat content.

3.1.2 Equipment

Equipment involved in this experiment is a knife, spoon, chopping board, bowl, blender, pan, stove, mold, weighing balance, beaker, spatula, glass rod, moisture analyzer, textural analyzer, digestion tube, conical flask, measuring cylinder (50 mL, 100 mL, and

500 mL), conical flask (250 mL), retort stand, burette, round bottle flask, Soxhlet machine, condenser, crucibles, muffle furnace.

3.1.3 Raw Materials

There are some materials involved to carry out this experiment. Fresh *P. speciosa* were collected from Jeli local market, while potato flour, low protein flour, egg, salt, sodium bicarbonate (baking powder), margarine, and oil was bought at the supermarket.

3.2 Methods

3.2.1 Experimental Design

This experiment was started with cleaning, followed by the dough making and frying process of *P. speciosa* snack. Three different formulations of *P. speciosa* snack was developed. These three formulations were performed for a few analyses, including physicochemical analysis and sensory evaluation. *P. speciosa* snack were ground to a fine powder and snacks were further analysed for their physicochemical properties. The nutritional values were measured using proximate analysis, including protein, fat, ash, and moisture, On the other hand, colour and texture analyses were performed to examine the formulated samples' colour and texture. The moisture content, lipids, proteins, and ash of the *P. speciosa* snacks were measured in triplicate using AOAC guidelines (Association of Official Analytical Chemistry, 1999). Meanwhile, all the three-formulations were further evaluated for the sensory evaluation to conclude which formulation was accepted by consumers.

3.2.2 Preparation of *P. speciosa* Snack

P. *speciosa* was collected from the local market in Jeli, Kelantan. *P. speciosa* were washed, and the seed was separated from the pods. The seeds grounded for 4 to 5 minutes to get a fine texture. The blended *P. speciosa* paste was divided into three different formulations (60%, 40%, and 20%). Then, all the ingredients such as flour, margarine, blended *P*. *speciosa*, egg, baking powder, and salt were mixed until it became a dough. The dough was mixed until it started looks like a shaggy, lumpy mass, completely smooth and slightly tacky to the touch. After that, the perfectly smooth dough was pressed into a mold. The dough was swirled in the mold until it came out and was deep-fried in hot oil. All three formulations undergo the same method.

Table 3.2: Three different formulations of *Parkia speciosa* Snack

Ingredients	Formulations		
	1	2	3
Potato Flour	250g	250g	250g
Low Protein Flour	100g	100g	100g
Parkia speciosa (petai)	160g	140g	120g
Egg	50g	50g	50g
Margarine	30g	30g	30g
Cashew Nuts	20g	20g	20g
Baking Powder	6g	6g	6g
Salt	6g	6g	6g
Water	-	20g	40g
Total		620g	

3.3 Physicochemical Analysis

3.3.1 Colour Analysis

In the food and bioprocess industries, colour is an important quality attribute, affecting consumer choices and preferences. Konica Minolta Chroma meter was used to measure the colour intensity of the *P. speciosa* snack. The *P. speciosa* snack was cracked into powder form. The powdered sample stored on a clear glass plate to detect the colour in the chromameter. The colour of samples was recorded in terms of *L** (lightness), *a** (green, -a to red, +a) and *b** (blue, -b to yellow, +b) and all the readings were taken in triplicate (n=3). Since it is easier, quicker, and correlates well with other physicochemical properties, colour measurement of food products has been used as an indirect measure of other quality attributes such as flavour and pigment content (Pankaj et al., 2013).

3.3.2 Texture Analysis

The texture is a property of a material that is perceived by the senses of touch, sight, and hearing and is the product of a combination of physical properties. The size, shape, number, nature, and conformation of the structural elements may include physical properties. Hence, the textural property of *P. speciosa* was measured using a texture analyser to evaluate the texture of *P. speciosa* snack based on the hardness, adhesiveness, fracturability, cohesiveness, and spring chewiness. The condition employed were; target= 3000g, trigger load= 5g, test speed= 10.00mm/s and return speed 10 mm/s. All the readings were taken in triplicate.

3.4 Proximate Analysis

3.4.1 Ash Content

The inorganic residue left after the ignition or complete oxidation of organic matter in a food sample is ash content. The ash content was determined using proximate analysis for nutritional evaluation, and it is a key quality attribute for some food ingredients (Baraem, 2017). *P. speciosa* snack's ash content was performed in triplicate using according to AOAC Methods. Briefly, around 5-10 g of grounded *P. speciosa* snack was weighed, into a tared crucible. The crucible was placed in a cool muffle furnace. The sample was ignited for 12–18 hours (or overnight) at about 550 ºC. The muffle furnace was switched off and waited to open until the temperature has dropped to at least 250 °C. Crucibles were moved to a desiccator equipped with a porcelain plate and desiccant. After that, the remaining ash was weighed and the average with standard deviation was calculated based on the following formula:

$\% \ Ash\ content = w1 - w2w \times 100$

w1 = weight of dried sample with crucible

w2 = weight of sample with crucible

w = weight of sample

3.4.2 Moisture Content

One of the essential consistency metrics for food products is moisture content. Moisture content has long been recognised as an important predictor of food shelf life. Moisture can evaluate the aesthetics of food and provide estimates for product shelf life regardless of whether the sample is wet or dry (Dairy food, 2010). Sartorius Moisture Analyzer was used to performed this test. As a result, 5 g of grounded *P. speciosa* snack was heated for 9 minutes at 140 °C, and the readings was taken in triplicate (n=3).

3.4.3 Protein Content

The popular Kjeldahl method was used to conduct this protein determination test according to AOAC method (Edson, 2016). Initially, the sample was weighted to 1g and placed in a digestion tube. Then, in a digestion tube, 1g of catalyst tablets was mixed with 12 mL of sulphuric acid. To set the catalyst and sulfuric acid ratio, a catalyst tablet was added to absolute performance. Due to a faster digestion process, a catalyst tablet introduced.

Next, the sample was inserted into the digester machine after prepared in a digestion tube. The sample was allowed to sit for 2 to 3 hours. The sample was initially digested at a low temperature to prevent a bubbling condition. Meanwhile, the digestion was continued until complete digestion. Then, the sample was heated until all organic compounds are thoroughly mixed and the liquid becomes translucent. The samples were removed from the digester and cool for at least 15 to 20 minutes.

On the other hand, 50 mL of 4% boric acid were applied to a conical flask and used as an indicator as a receiver on the distillation machine. The digested sample was mixed with 80 mL distilled water and 50 mL of 40% sodium hydroxide to begin the distillation process. As a result, the distillation process continues until all of the ammonia in the sample is released.

The receiver conical flask was brought in as the final step in the titration process. Before the titration, a standardized 0.1 N hydrochloric acid was prepared. The distillate was titrated until a pink colour appeared, and the amount of hydrochloric acid registered for calculations using the following formula:

% Protein = % nitrogen x factor

$$\% \text{ Nitrogen} = \frac{(\text{mL standard acid - mL blank}) \times \text{N of acid} \times 14}{\text{Weight of sample}}$$

3.4.4 Lipid Content

The Soxhlet method is a traditional method for extracting lipids from foods that involve drying the sample, grinding it into small pieces, and placing it in a porous thimble. The flask, extraction chamber, and condenser are the three main compartments (Geeth et al., 2020). 2 g of *P. speciosa* snack powdered sample was placed in an extraction thimble with petroleum ether. The weight of a pre-dried round blotted sample was then taken. After that, the sample was covered in a sheet of de-fatted cotton. The sample was inserted into the extraction device before the magnets are attached. Extraction in the Soxhlet extractor was started at a rate of 5 or 6 drops per second condensation for approximately 4 hours after heating the solvent inside the round bottled flask. This prolongs the time the sample spends in contact with the solvent, allowing all of the fat in the sample to be dissolved.

Finally, the extracted fat and flasks were placed in an oven for 30 minutes at 105 °C, and the weight was recorded. Afterward, it was cooled and weighed again in the desiccator. The weight was required to ensure that no further weight loss occurs. The fat content was calculated using the weight of the contents of the receiver flask using the following formula:

$$\% \text{ Crude fat} = \frac{(W2 - W1) \times 100}{\text{Sample(g)}}$$

W1 = Weight of empty flask

W2 = Weight of extracted fat and flask

S = Sample

3.5 Sensory Evaluation

Thirty untrained panellists of both sexes were participated in the sensory evaluation to estimate the acceptance of the *P. speciosa* snacks after frying. On a hedonic scale ranging from 1 (extreme dislike) to 7 (like extremely), the assessors will be asked to rate how much they liked the taste, appearance, flavour, texture, and overall acceptability of the *P. speciosa* snack. The samples were presented in white plastic dishes labeled with three-digit random numbers. The panelists were instructed to thoroughly rinse their mouths with potable water in between sample evaluations and to taste the snack samples one by one.

3.6 Statistical Analysis

Following sensory evaluation, all *P. speciosa* snack the recorded data was analysed using one-way analysis of variance (ANOVA) in the Statistical Package for Social Science (SPSS) to ensure accurate consumer acceptability results. Meanwhile, to find the best formulation, the recorded data results from the physicochemical analysis were compared among the three different formulations.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Production of *Parkia speciosa* Snack

This study produced a snack using *P. speciosa* using three different formulations. The study aims to study the physicochemical and sensory evaluations of developed snacks made from *P. speciosa* bean. Besides potato flour, low-protein flour, *P. speciosa* (stink bean), margarine, egg, salt, cashew nuts and baking powder are necessary for *P. speciosa* snack were used to produce the snack made with *P. speciosa* snack. Figure 4.1 shows *P. Speciosa* snack. In addition, two analyses of physicochemical properties of snacks made off with *P. speciosa* were performed, including determination of colour and texture. On the other hand, four different proximate analyses were carried out to determine the value of macronutrients in *P. speciosa* snack, such as ash, moisture, protein, and fat contents. Lastly, sensory analysis was conducted to ensure consumer acceptance of the product in terms of colour, texture, aroma, taste, and overall acceptance. All these analyses were analysed and compared with the control sample.

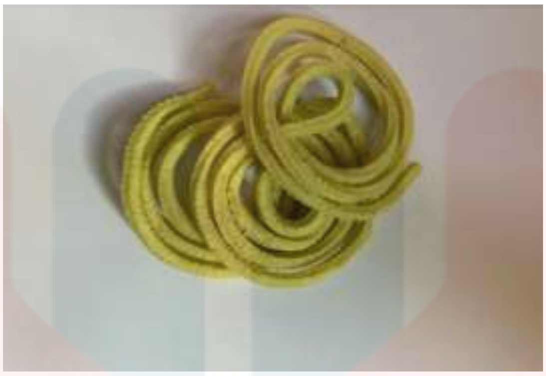

Figure 4.1: *Parkia Speciosa* snack

4.2 Physicochemical Properties of *Parkia speciosa* Snack

The purpose of this study was to determine the physicochemical properties of *P. speciosa* snack, such as colour analysis and texture analysis. All three formulations of *P. speciosa* snack incorporated with *P. speciosa* and one of control sample were analysed by Konica Minolta Chromameter for colour analysis and texture profile analysis (TPA).

4.2.1 Colour Analysis

In terms of colour analysis, the CIE Lab colour space or coordinated L*, a*, and b* were used to determine the colour intensity of the samples. Each chromatic coordinate represents a different attribute, with L* indicating lightness (0-100), a* indicating green (negative value) or red (positive value), and b* indicating blue (negative value) or yellow (positive value) (Granato et al., 2010). Figures 4.2, 4.3, and 4.4, which demonstrated the sample's colour changes, indicated that the colour of the *P. speciosa* snack changed after being deep-fried in oil. Each of the three formulations indicates a different colour. Formulation 1 turned brown/golden in colour, while formulation 2 was green, and formulation 3 was light green. The green colour was achieved through the addition of *P. speciosa.* The incorporation of *P. speciosa* did affect the colour of the snack. Hence, caramelization or Maillard reaction processes are responsible for developing gold to brown colour. In addition, it can produce changes in the evaporation of food surface, which characterizes crust formation and is responsible for the texture of fried food (Bordin et al., 2013). Therefore, the Maillard reaction is regarded as the most critical reaction in food browning. Thus, *P. speciosa* snack and a control sample were tested for colour intensity by measuring three coordinates of L*, a*, and b* to observe colour changes. Table 4.2 summarizes the significant difference of colour analysis coordinates in three different formulations and control samples for statistical analysis.

Figure 4.2: Colour changes in Formulation 1

Figure 4.3: Colour changes in Formulation 2


Figure 4.3: Colour changes in Formulation 3

Table 4.2: Least significant difference test on colour coordinates tested on *P. speciosa* snack

Sample	Colour		
	L*	a*	b*
F1	74.67 ± 0.52^{b}	-2.53 ± 0.04^{b}	23.89 ± 0.20^{a}
F2	78.48 ± 1.58^{a}	-3.81 ± 0.04^{c}	24.43 ± 0.17a
F3	80.30 ± 0.71^{a}	-2.43 ± 0.16^{b}	22.76 ± 0.43^{b}
C	70.93 ± 0.57^{c}	3.42 ± 0.19^{a}	19.23 ± 0.33^{c}

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with superscript of different letter are significantly different (p<0.05).

Based on Table 4.2, the L* value indicates the lightness of the sample, whereas the lighter the colour, the higher the value of lightness. The result indicates that the lightness (L*) of the composite snack (F1-F3) displayed an increasing trend along with the decreasing addition level of *P. speciosa*. It increased from 74.67 ± 0.52 (F1) to 80.30

± 0.71 (F3). Hence, as the substitution level increases, the decreasing value of L* indicates that the composite snacks become darker in colour. Consequently, the lightness of control (70.93 ± 0.57) much varies compared to other formulations because the snack is plain without adding *P. speciosa*.

On the other hand, the a* indicates the greenness with negative values except for control (3.42 ± 0.19) which was noticed as redness. F1, F1 and F3 (-2.53 ± 0.04, -3.81 ± 0.04, -2.43 ± 0.16) have a negative value because it has darkest shade of green. Whereas, the green colour indicates the presence of chlorophyll that gives green colour to the snack (Gan & Latiff, 2011). Comparing these three samples, F2 is said to have the darkest green because it has a moderate level of *P. speciosa* on it. The quantity of *P. speciosa* in F1 is high while F3 is the lowest. These colours are caused by maillard reactions between amino acids and reducing sugar during the frying process (Cheng & Bhat, 2015). Whereas, b* indicates the yellowness, which is a positive value. Control act as a control variable in this experiment. Therefore, it does not show any colour difference. In term of yellowness, F2 (24.43 ± 0.17) have higher value compare to F1 (23.89 ± 0.20) and F3 (22.76 ± 0.43).

4.2.2 Texture Analysis

Table 4.3: Textural parameters in *P. speciosa* snack

Sample	Texture Parameters					
	Hardness (N)	Fracturability (N)	Adhesiveness (mJ)	Cohesiveness	Springiness (cm)	Chewiness (mJ)
F1	3215.66±183.7^{b}	246.67±103.37^{b}	0.17±0.12^{a}	0.83±0.36^{a}	1.67±0.13^{b}	54.13±15.44^{a}
F2	3320.6±102.62^{b}	398.33±19.14^{b}	0.27±0.29^{a}	0.54±0.30^{a}	0.72±0.71^{b}	41.5±17.05^{ab}
F3	3333.33±528.51^{a}	554±126.68^{b}	0.03±0.05^{a}	1.21±0.7^{a}	0.09±0.06^{b}	32.17±12.37^{ab}
C	3235.66±52.38^{b}	1864.67±639.6^{a}	0.13±0.06^{a}	0.84±0.6^{a}	0.3±0.16^{b}	16.07±10.39^{b}

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with superscript of different letter are significantly different ($p<0.05$).

The results of the texture profile analysis of *P. speciosa* snack and control samples in terms of fracturability, hardness, cohesiveness, adhesiveness, chewiness, and springiness are shown in Table 4.3. The hardness was found to be higher among the textural parameters. This is because a study stated that at a constant temperature, the hardness increased significantly. This could be attributed to partial protein denaturation and rapid gelatinization of surface starch after the initial frying (Bouchon et al., 2001). Deep-fried food had higher hardness. According to Joshy et al. (2020), the sample/food changed from soft to hard with a crispier crust due to prolonged exposure to heat, water, and sheer stress. Consequently, the starch granules and other ingredients began to gelatinize, giving the product structure and a more solid texture (Joshy et al., 2020).

Results suggested that increase the level of hardness with a decrease in the level of *P. speciosa* (F1-F3), which led to the hardness of the snack. Hence, the hardness of *P. speciosa* snack and control not significantly varied (p>0.05).

In addition, with regard to textural properties, the fracturability increased progressively corresponding to the *P. speciosa* substitution level. The control sample showed the highest fracturability, whereas the snack made from 20% *P. speciosa* showed the lowest (246.67±103.37N). Therefore, the fracturability of *P. speciosa* snack and the control sample varied significantly (p<0.05). Meanwhile, the adhesiveness found be highest in F2 (0.27±0.29mJ), containing a moderate proportion of *P. speciosa* and F1, F3 and control. This is maybe due to the sticky nature of amylopectin present in potato starch (Svegmark at al., 2002; Thanushree et al., 2012). However, cohesiveness did not show any regular trend due to a heterogeneous mixture (Thanushree et al., 2012). Both adhesiveness and cohesiveness are not significantly varied (p>0.05). The decrease in springiness and chewiness as the proportion of *P. speciosa* in formulation. This is maybe reduced due to the inherent granular structure and different physicochemical properties of potato starch and low protein flour during the kneading process (Choy et al., 2012).

4.3 Proximate Analysis

4.4 Ash Content Determination in *Parkia speciosa* Snack

Table 4.4: Total ash content in *Parkia speciosa* snack

Sample	Ash Content ± Standard Deviation (%)
F1	4.34 ± 0.37[a]
F2	3.93 ± 0.32[a]
F3	3.08 ± 0.12[b]
C	2.47 ± 0.19[b]

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with superscript of different letter are significantly different ($p<0.05$).

The ash content of foods represents the total mineral content (Food Science, 2012). A study stated that even though minerals make up a small percentage of dry matter, often less than 7%, they play an essential role in physicochemical, technological, and nutritional processes (Food Science, 2012). Rather than that, the analysis of ash content in food is simply burning away of organic content and leaving inorganic minerals (Dairy foods, 2010).

The ash content of *P. speciosa* snack and control sample is depicted in Table 4.4. The *p* value for ash content is below 0.05 ($p<0.05$) which means significant. From the result, the ash content decreases significantly from 4.34 ± 0.37% to 2.47 ± 0.19% as the substitution level of *P. speciosa* decreases. However, the highest value of ash content was F1 (4.34 ± 0.37%) while the lowest value of ash was C (2.47 ± 0.19%). Therefore, the higher ash content in *P. speciosa* snacks suggests high mineral content.

4.5 Moisture Content Determination in *Parkia speciosa* Snack

Table 4.5: Moisture Content in *Parkia speciosa* Snack

Sample	Moisture Content ± Standard Deviation (%)
F1	3.68 ± 0.16^{ab}
F2	3.54 ± 0.05^{ab}
F3	3.83 ± 0.01^{c}
C	1.76 ± 0.10^{b}

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with superscript of different letter are significantly different ($p<0.05$).

The moisture content of the *P. speciosa* snack is shown in Table 4.5. The moisture content of the snack varied among three different formulations and control samples. Based on the result, it was noticed that the moisture content of *P. speciosa* snack had decreased significantly from 3.68 ± 0.16% to 1.76 ± 0.10%, corresponding to the decrease in the levels of *P. speciosa* substitution. Therefore, it can say that the decrease in the amount of *P. speciosa* decreases the moisture content. It was seen that the control sample had less (1.76 ± 0.10%) moisture compared to the other three formulations. Based on research, the *P. speciosa* seeds' moisture content was found to be between 68.59-77.70% (Abdullah et al., 2011). The most important factor affecting the seed's storability is its moisture content. Therefore, the higher the moisture content, the shorter the storage life of the seed due to the rapid growth of mould in the seed (Abdullah et al., 2011). Hence, that's maybe why F1, F2 and F3 have higher moisture content than control, since control act as a control variable in this experiment that does not contain *P. speciosa*.

In addition, deep frying is a process of simultaneous heat and mass transfer. Heat is transferred from the oil to the food, resulting in the evaporation of water from the food and the absorption of oil by the food (Debnath et al., 2003). Hence, the low moisture content of the snack could be attributed to the water evaporation that occurs during the deep frying of food (Flores Silva et al., 2015).

4.6 Protein Content Determination in *Parkia speciosa* Snack

Table 4.6: Protein Content in *Parkia speciosa* Snack

Sample	Protein Content ± Standard Deviation (%)
F1	3.08 ± 0.73^{a}
F2	2.1 ± 0.28^{a}
F3	1.54 ± 0.28^{a}
C	1.45 ± 0.77^{b}

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with superscript of different letter are significantly different (p<0.05).

Protein content was determined using the Kjedhal's method, that involved three main steps: digestion, distillation and titration. The protein content of snacks substituted with different levels of *P. speciosa* and control sample is shown in Table 4.6. The protein content of *P. speciosa* snack and control varied significantly ($p<0.05$). Meanwhile, the protein content decreased significantly from 3.08 ± 0.73% to 1.45 ± 0.77% as the substitution level of *P. speciosa* was decreased. From the results, the control snack was low in protein content, indicating that this sample contained a small amount of protein content.

In addition, results from the study indicated that the addition of *P. speciosa* into the snack formulations shows a high protein content compared to control. This is because legumes are typically higher in protein compared to cereals such as rice (5-8%), millet (7%), and sorghum (10%) (Cheng & Bhat, 2015). As a result, it was expected that *P. speciosa* snack would have higher protein content. On the other hand, the results show that F1, F2, and F3 have higher protein content compared to the control sample. Among that, F1 contain higher protein content. This can be attributed to incorporating *P. speciosa* which possesses higher protein content, as reported in Table 4.6. Therefore, it could say that the higher the amount of *P. speciosa* the higher the amount of protein.

4.7 Fat Content Determination in *Parkia speciosa* Snack

The Soxhlet method, which involved the use of an organic solvent, was used to determine fat content. Because fat is only soluble in organic solvents and is insoluble in water, an organic solvent must be used to extract fat from food samples (Nielsen, 2010). Therefore, petroleum ether was chosen as an organic solvent for determining the control and *P. speciosa* snack. Basically, the most important factor influencing the amount of fat absorbed by the snack was the frying temperature (Kita et al., 2007). Hence, the fat content of the deep-fried *P. speciosa* snack differed significantly (p<0.05).

Table 4.7: Fat Content in *Parkia speciosa* Snack

Sample	Fat Content ± Standard Deviation (%)
F1	63.89 ± 5.02^{b}
F2	59.24 ± 22.91^{b}
F3	33.33 ± 4.25^{b}
C	88.7 ± 14.17a

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with superscript of different letter are significantly different (p<0.05).

The results of the fat content of *P. speciosa* and the control sample were presented in Table 4.7. Fat content was ranged from 63.89 ± 5.02% to 88.7 ± 14.17%. It can be observed that control (88.7 ± 14.17%) has higher fat content than the other formulations due to the absence of oil. Hence, the fat content was found to be decreasing (F1-F3) when the level of *P. speciosa* decrease. F1 stated the higher fat content (63.89 ± 5.02%). The higher fat content might be due to fat drainage from *P. speciosa* and other ingredients.

Basically, the higher fat content in deep-fried samples could be attributed to an equilibrium reaction between adhesion and drainage on the surface of the snack when it is removed from the oil (Joshy et al., 2020). Research has stated that during frying, the water in the raw material evaporates and is partially replaced by oil, which accounts for up to 40% of the finished product and thus influences its properties (Kita et al., 2007). However, this affects not only the flavour and aroma of the product but also the texture, which varies depending on the amount of oil absorbed during frying - from oily when the fat content is too high to harsh and less crispy when it is too low (Kita et al., 2007).

4.4 Sensory Evaluation

Sensory evaluation was carried out to determine the overall acceptability of the panellist towards *P. speciosa* snack. Thirty un-trained panellists were recruited, and they were provided with a sensory evaluation form of 7-point hedonic scale with 1 representing extremely dislike; 2='Moderately dislike'; 3= 'Slightly dislike'; 4= 'Neither like or dislike'; 5= 'Slightly like'; 6= 'Moderately like' and 7 as the highest score 'extremely like'. The attributes of *P. speciosa* snack that evaluated by panelists were aroma, colour, texture in terms of crispiness, taste, and overall acceptability. Based on the results, the control sample obtained the lowest scores for aroma (3.93 ± 1.99), colour (4.4 ± 1.63), texture (4.43 ± 2.19), taste (4.5 ± 2.32), and overall acceptability (4.87 ± 1.91).

Table 4.8: Sensory attributes of *Parkia speciosa* snack

Samples	Sensory Attributes				
	Aroma	Colour	Texture (Crispiness)	Taste	Overall Acceptability
F1	4.37 ± 1.96	5.43 ± 1.28	5.9 ± 1.35	4.8 ± 2.09	5.17 ± 1.78
F2	5.87 ± 0.97	6.07 ± 0.83	6.10 ± 0.76	5.83 ± 1.21	6.1 ± 0.88
F3	5.53 ± 1.11	5.6 ± 1.19	6.23 ± 0.86	5.67 ± 1.35	5.63 ± 1.27
C	3.93 ± 1.99	4.4 ± 1.63	4.43 ± 2.19	4.5 ± 2.32	4.87 ± 1.91

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with superscript of different letter are significantly different ($p<0.05$).

The sensory scores of *P. speciosa* snack are depicted in Table 4.8. The result found that 40% *P. speciosa* substitution level, which is formulation 2 scores the highest sensory attributes (aroma, colour, taste, overall acceptability) except for texture. Whereas F3 has the highest score (6.23 ± 0.86) for texture. A significant difference was observed among all attributes of *P. speciosa* snack.

The aroma was defined as the sense of smell before the consumption of the snack. Aroma is one of the important features of snack quality. This can decide the consumer's preference as to accept or reject the snack before tasting it. The mean score for the aroma of *P. speciosa* snack is ranged from 4.37 ± 1.96 to 3.93 ± 1.99. For the parameter of aroma in *P. speciosa* snack, formulation 2 had the highest score (5.87 ± 0.97) while the lowest score was control (3.93 ± 1.99). This is due to the control sample does not contain any *P. speciosa* on the snack. Primarily, *P. speciosa* also known as petai, has earned the nicked name "stink bean" because its strong, pungent smell is pervasive. The smell of petai suggests it has sulfur-containing compound (Amarnath, 2004). The strong and unpleasant odour in *P. speciosa* is caused by hydrogen sulphide and cyclic polysulphides (Amarnath, 2004). In conclusion, those panelists who chose F1, F2, and F3 could say that they are petai lovers and prefer the smell of *P. speciosa* in the snack.

In addition, colour is the first sight of consumers looking at products' appearance. Thus, it is important to evaluate the product's marketability in the market. Hence the mean score of colours were ranged from 5.43 ± 1.28 to 4.4 ± 1.63. Formulation 2 has the highest scores while the control sample has the lowest scores. However, the score concern to the colour decreased from 6.07 ± 0.83 to 4.4 ± 1.63. This is due to the reason that the panelists prefer snacks with slightly green colour than the control.

Besides, the taste is considered as the sensations in the mouth. In terms of taste, consumers liked the flavour of *P. speciosa*, which was indicated by the mean rating of F1, F2, and F3 (4.8 ± 2.09, 5.83 ± 1.21, 5.67 ± 1.35). While control sample has rated the lowest score (4.5 ± 2.32). The intense decrease in mean scores can be attributed to the intense characteristics taste of *P. speciosa* snack. Like the overall liking result, taste like has the majority responses towards formulation 2. F1 contained more *P. speciosa* (60%) compared to F2 (40%), and F3 (20%) caused a strong petai taste, which panellists did not accept. Hence, F2 was more acceptable by the sensory panellist since it has a moderate amount of *P. speciosa*. However, Cheng and Bhat (2015) proposed using household thermal treatments such as steaming on legumes to improve seed meals' overall aroma and taste.

As for texture, the mean scores were adversely affected with decreasing level of *P. speciosa* in the snack. The formulation 3 (20% of *P. speciosa*) snacks were rated the highest (6.23 ± 0.86), whereas the control sample scored the lowest (4.43 ± 2.19). Panelists show that they are more prefer to eat a crunchy snack. This is because the main snack texture probably is crunchiness. On the other hand, an increase in mean scores for texture can be attributed to the fact that the snack becomes harder when more *P. speciosa* is incorporated in the formulations. Lastly, the mean score for overall acceptability ranged from 5.17 ± 1.78 to 4.87 ± 1.91. The overall acceptability of the snack was evaluated based on organoleptic properties such as aroma, colour and taste of the snack. Formulation 2 was obtained the highest score of overall acceptability because it received all the likeness except for texture among the sensory attributes. The percentage of *P. speciosa* for F2 is 40%, which is 20% less and more compared to F1 and F3. Hence, the pungent smell and taste of *P. speciosa* may affect consumers' preference. The consumer has accepted the taste of *P. speciosa.*

Overall, the sensory panelists accepted F2 *P. speciosa* snack. In addition, panelists tend to like to consume *P. speciosa* because the majority of the panelists chose the moderate taste and aroma of petai. It was noticed that snacks prepared without *P. speciosa* (C) were rated the lowest for all sensory attributes evaluated. This could be because the snack was pale in colour, softer, exhibiting the characteristic flavour.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study was the first attempt to develop a novel snack by adding *Parkia speciosa* (petai). The proximate composition of this snack has been reported in the study. According to sensory evaluation, formulation 2 (40%) was organoleptically more acceptable than F1, F3, and Control. Consequently, the results obtained in the present study have stated that F1 has higher ash and protein content than F2, F3 and control. Since, *P. speciosa* seeds naturally contain higher minerals and protein content, the three formulations have higher minerals and protein than the control sample. Hence, it proved that F1, F2, and F3 have the best amino acids. Apparently, F3 has less fat content than F1, F2 and control. Overall, according to sensory evaluation, F2 *P. speciosa* snack was more acceptable by the sensory panelists. In addition, panelists tend to like to consume *P. speciosa* because most of the panelists chose the moderate taste and aroma of petai. Hence, the pungent smell and taste of *P. speciosa* may affect consumers' preference. The taste of *P. speciosa* have been accepted by the consumer.

5.2 Recommendation

This present study showed that *Parkia speciosa* snack is made with an underutilized legume. *P. speciosa* also known as ‘petai’, is a well-known vegetable, but no downstream product is produced from this vegetable. Therefore, to make *P. speciosa* notable to all consumers, this research developed a snack made from *P. speciosa*. On the other hand, sensory evaluation among the panelists has proven that *P. speciosa* have been accepted by the consumers. For further study, it is recommended that *P. speciosa* snack be combined with the pods/skin of *P. speciosa*. Also, could improvise the nutrition content of the snack. This present study also recommended to conduct a stability test after improvising *P. speciosa* snack.

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APPENDIX A

Figure A.1: *P. speciosa* snack

Figure A.2: Konica Minolta Colorimeter

Figure A.3: TPA Analysis

APPENDIX B

Survey on Consumer Acceptability Against the Snack Made Off with *Parkia Speciosa*

A) Demographic of panelists

1. **Gender:** ☐ **Male** ☐ **Female**
2. **Race:** ☐ **Malay** ☐ **Chinese** ☐ **Indian** **Others: -----------------**
3. **Age:** ☐ **19-21**
   ☐ **22-24**
   ☐ **25-27**
   ☐ **28-30**
   ☐ **>30**

Announcement on Sensory Evaluation

Please be advised that you are going to try the snack accordance with the code provided. Please drink plain water before every tasting to avoid remnant taste of previous snack sample.

B) Sensory Evaluation

The 7-point hedonic scale is being used and displayed using number, from 1 (EXTREMLY DISLIKE) 7 (EXTREMLY LIKE)

The scale is listed as below:

1 - Extremely DISLIKE

2 - Moderately DISLIKE

3 - Slightly DISLIKE

4 - Neither LIKE nor DISLIKE

5 - Slightly LIKE

6 - Moderately LIKE

7 - Extremely LIKE

1. **Please rate the snack with the code 358.**

	Extremely dislike	Moderately dislike	Slightly dislike	Neither like nor dislike	Slightly like	Moderately like	Extremely like
Aroma							
Colour							
Texture (Crispiness)							

Taste							
Overall Acceptability							

2. Please rate the snack with the code 323.

	Extremely dislike	Moderately dislike	Slightly dislike	Neither like nor dislike	Slightly like	Moderately like	Extremely like
Aroma							
Colour							
Texture (Crispiness)							
Taste							
Overall Acceptability							

3. Please rate the snack with the code 305.

	Extremely dislike	Moderately dislike	Slightly dislike	Neither like nor dislike	Slightly like	Moderately like	Extremely like
Aroma							
Colour							

Texture (Crispiness)							
Taste							
Overall Acceptability							

4. Please rate the snack with code 313.

	Extremely dislike	Moderately dislike	Slightly dislike	Neither like nor dislike	Slightly like	Moderately like	Extremely like
Aroma							
Colour							
Texture (Crispiness)							
Taste							
Overall Acceptability							

APPENDIX C

Colour

ANOVA

Dependent variable: Colour

		Sum of Squares	df	Mean Square	F	Sig.
L	Between Groups	156.309	3	52.103	58.082	.000
	Within Groups	7.177	8	.897		
	Total	163.486	11			
a	Between Groups	93.440	3	31.147	1831.256	.000
	Within Groups	.136	8	.017		
	Total	93.576	11			
b	Between Groups	48.116	3	16.039	177.844	.000
	Within Groups	.721	8	.090		
	Total	48.837	11			

Report

Sample		L	a	b
F1	Mean	74.6733	-2.4333	23.8900
	N	3	3	3
	Std. Deviation	.51733	.03786	.19672
F2	Mean	78.4800	-3.8067	24.4300
	N	3	3	3
	Std. Deviation	1.57839	.04933	.17088
F3	Mean	80.3000	-2.4267	22.7600
	N	3	3	3
	Std. Deviation	.70704	.16289	.42884
C	Mean	70.9267	3.4233	19.2833
	N	3	3	3
	Std. Deviation	.57396	.19399	.33005
Total	Mean	76.0950	-1.3108	22.5908
	N	12	12	12
	Std. Deviation	3.85517	2.91666	2.10707

Texture

ANOVA

Dependent variable: texture

		Sum of Squares	df	Mean Square	F	Sig.
Hardness	Between Groups	31646.000	3	10548.667	.129	.940
	Within Groups	652770.667	8	81596.333		
	Total	684416.667	11			
Fracturability	Between Groups	4970694.917	3	1656898.306	15.194	.001
	Within Groups	872380.000	8	109047.500		
	Total	5843074.917	11			
Adhesiveness	Between Groups	.083	3	.028	1.075	.413
	Within Groups	.207	8	.026		
	Total	.290	11			
Cohesiveness	Between Groups	.673	3	.224	.734	.560
	Within Groups	2.442	8	.305		
	Total	3.115	11			
Springiness	Between Groups	.715	3	.238	1.733	.237
	Within Groups	1.101	8	.138		
	Total	1.816	11			
Chewiness	Between Groups	4160.989	3	1386.996	3.597	.066
	Within Groups	3084.940	8	385.617		
	Total	7245.929	11			

Report

Sample		Hardness	Fracturability	Adhesiveness	Cohesiveness	Springiness	Chewiness
F1	Mean	3215.6667	246.6667	.1667	.8267	.1667	54.1333
	N	3	3	3	3	3	3
	Std. Deviation	183.79971	103.37472	.11547	.36295	.13279	15.44355
F2	Mean	3320.6667	398.3333	.2667	.5433	.7200	41.5000
	N	3	3	3	3	3	3
	Std. Deviation	102.62716	19.13984	.28868	.30139	.71077	17.05198
F3	Mean	3333.3333	554.0000	.0333	1.2100	.0867	32.1667
	N	3	3	3	3	3	3
	Std. Deviation	528.51332	126.67675	.05774	.79731	.05859	12.37147
C	Mean	3235.6667	1864.6667	.1333	.8400	.2967	16.0667
	N	3	3	3	3	3	3
	Std. Deviation	52.38638	639.60170	.05774	.60233	.15503	10.39247

Total	Mean	3276.3333	765.9167	.1500	.8550	.3175	35.9667
	N	12	12	12	12	12	12
	Std. Deviation	249.43876	728.82689	.16237	.53212	.40632	18.81476

Protein Content

ANOVA

Dependent Variable: Protein content

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.062	3	1.687	5.270	.027
Within Groups	2.561	8	.320		
Total	7.623	11			

Report

Protein_content

Sample	Mean	N	Std. Deviation
F1	3.0800	3	.72746
F2	2.1000	3	.28000
F3	1.5400	3	.28000
C	1.4467	3	.77106
Total	2.0417	12	.83245

Fat

ANOVA

Dependent variable: Fat_content

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4632.459	3	1544.153	8.031	.008
Within Groups	1538.148	8	192.269		
Total	6170.607	11			

Report

Dependent variable: Fat_content

Sample	Mean	N	Std. Deviation
F1	63.8800	3	5.02346
F2	59.2433	3	22.91027
F3	33.3267	3	4.25113
C	88.7000	3	14.17344
Total	61.2875	12	23.68468

Sensory Evaluation

ANOVA

Dependent variable: sensory

		Sum of Squares	df	Mean Square	F	Sig.
Aroma	Between Groups	76.558	3	25.519	10.216	.000
	Within Groups	289.767	116	2.498		
	Total	366.325	119			
Colour	Between Groups	44.492	3	14.831	9.267	.000
	Within Groups	185.633	116	1.600		
	Total	230.125	119			
Texture	Between Groups	62.533	3	20.844	10.507	.000
	Within Groups	230.133	116	1.984		
	Total	292.667	119			
Taste	Between Groups	38.067	3	12.689	3.903	.011
	Within Groups	377.133	116	3.251		
	Total	415.200	119			
Overall_acceptability	Between Groups	26.292	3	8.764	3.803	.012
	Within Groups	267.300	116	2.304		
	Total	293.592	119			

Report

Dependent variable: sensory

Sample		Aroma	Colour	Texture	Taste	Overall_acceptability
F1	Mean	4.3667	5.4333	5.9000	4.8000	5.1667
	N	30	30	30	30	30
	Std. Deviation	1.95613	1.27802	1.34805	2.09103	1.78274
F2	Mean	5.8667	6.0667	6.1000	5.8333	6.1000
	N	30	30	30	30	30
	Std. Deviation	.97320	.82768	.75886	1.20583	.88474
F3	Mean	5.5333	5.6000	6.2333	5.6667	5.6333
	N	30	30	30	30	30
	Std. Deviation	1.10589	1.19193	.85836	1.34762	1.27261
C	Mean	3.9333	4.4000	4.4333	4.5000	4.8667

	N	30	30	30	30	30
	Std. Deviation	1.99885	1.63158	2.19220	2.31561	1.90703
Total	Mean	4.9250	5.3750	5.6667	5.2000	5.4417
	N	120	120	120	120	120
	Std. Deviation	1.75453	1.39062	1.56824	1.86791	1.57072

Thesis draft saa

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