EFFECT OF [illegible] ENRICHED BRIS SOIL ON THE FRUIT CHARACTERISTICS AND PROXIMATE ANALYSES OF PUMPKIN (*Cucurbita maxima* L.)

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EFFECT OF POMSC ENRICHED BRIS SOIL ON THE FRUIT CHARACTERISTICS AND PROXIMATE ANALYSES OF PUMPKIN (*Cucurbita maxima* L.)

by
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Research Report submitted in partial fulfilment of the requirements for the degree of Bachelor of Science in Agrotechnology (Post Harvest Technology)

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ENDORSEMENT

The project report entitled **EFFECT OF POMSC ENRICHED BRIS SOIL ON THE FRUIT CHARACTERISTICS AND PROXIMATE ANALYSES OF PUMPKIN (*Cucurbita maxima* L.)** by **NIK AISYAH BINTI NIK MUHAMMAD@ MOHD**, Matric No. **UK 15948** has been reviewed and corrections have been made according to the recommendations by examiners. This report is submitted to the Department of Agrotechnology in partial fulfilment of the requirement of the degree of Bachelor of Science in Agrotechnology (Post Harvest Technology), Faculty of Agrotechnology and Food Science, Universiti Malaysia Terengganu.

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DECLARATION

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ABSTRACT

Pumpkin (*Cucurbita maxima* L.) is from the family of *Cucurbitaceae* and the fruits are globular in shape with strong flavoured yellow orange flesh. The plants grow by absorbing nutrients from the soil and their ability to do this depends on the nature of the soil. BRIS soil with addition of palm oil mill sludge cake (POMSC) helps to improve water holding capacity, increase poor cation exchange capacity (CEC), increase inherent soil status, increase drainage and decrease moisture stress in BRIS soil. This study was conducted to investigate the physical characteristics and nutritional compositions of pumpkin cultivated on different types of soil treatments involving POMSC. The physical characteristics studied were fruit weight, size, pulp and skin colour and pulp texture. Meanwhile, the nutritional compositions involved quantitative measurements of all the proximate analyses (water, protein, fat, ash, fibre and carbohydrate). The preliminary studies done on the soil NPK analyses showed that POMSC contained higher, N, P and K values. Therefore, BRIS soil with more addition of POMSC contained higher NPK. The analyses done on the pumpkins showed that those cultivated on BRIS soil with 34 t/ha POMSC had significantly higher nutritional contents mainly protein and fibre but lower fat and carbohydrates compared to pumpkins cultivated on BRIS soil with 22t/ha POMSC and BRIS soil control. However, the fruits from BRIS soil with 34t/ha POMSC were slightly smaller in the size due to higher number of fruits per plants compared to the other soil treatments. The high content of NPK in POMSC might explained the higher nutritional content obtained in the pumpkins cultivated on BRIS soil with 34t/ha POMSC.

ABSTRAK

Labu (*Cucurbita maxima* L.) adalah dari famili *Cucurbitaceae* dan buahnya adalah berbentuk bundar dengan isi kuning kejinggaan dan aroma/rasa yang kuat. Pokok tumbuh dan membesar dengan menyerap nutrisi daripada tanah dan kebolehan untuk menyerap air bergantung kepada sifat semulajadi tanah. Tanah Bris yang dicampur dengan enap cemar kilang kelapa sawit (POMSC) dapat menolong meningkatkan kebolehan memegang air, meningkatkan pertukaran kation yang lemah, meningkatkan kebolehan semulajadi tanah, meningkatkan penyaliran dan mengurangkan tekanan kelembapan dalam tanah Bris (mengurangkan larut lesap nutrien ke dalam tanah). Kajian telah dijalankan untuk menyiasat ciri-ciri fizikal dan komposisi nutrisi buah labu yang ditanam di atas rawatan tanah melibatkan POMSC. Ciri-ciri fizikal yang dikaji adalah berat labu, warna isi dan kulit dan tekstur isi. Sementara itu, komposisi nutrisi melibatkan pengukuran kuantitatif analisis proksimat (kandungan air, protein, lemak, abu, gentian serat dan karbohidrat). Kajian awal yang telah dijalankan ke atas analisis NPK tanah menunjukkan POMSC mengandungi nilai N, P dan K yang tinggi. Oleh itu, tanah Bris yang dicampur dengan POMSC mengandungi nilai NPK yang lebih tinggi. Analisis yang telah dijalankan ke atas labu menunjukkan labu yang ditanam di atas campuran tanah Bris dengan 34 tan/ha POMSC mempunyai kelebihan yang ketara terutama dari segi kandungan protein dan gentian seratnya manakala kandungan lemak dan karbohidratnya lebih rendah berbanding labu yang ditanam di atas campuran tanah Bris dengan 22 tan/ha POMSC dan tanah Bris kawalan. Walaubagaimanapun, buah yang ditanam di atas campuran tanah Bris dengan 34 tan/ha POMSC bersaiz lebih kecil kerana bilangan buah untuk setiap pokok adalah lebih banyak berbanding rawatan tanah yang lain. Kandungan NPK yang tinggi di dalam POMSC ini boleh menjelaskan mengapa kandungan nutrisi yang diperolehi adalah lebih tinggi di dalam labu yang ditanam di atas campuran tanah Bris dengan 34 tan/ha POMSC.

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LIST OF ABBREVIATIONS

%	Percentage
±	Plus minus
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
BRIS	Beach Ridges Interspersed with Swales
Ca	Calcium
CHO	Carbohydrate
cm	Centimetre
H_3BO_3	Boric acid
HCl	Hydrochloric acid
HNO_3	Nitric acid
K	Potassium
Mg	Magnesium
mm/sec	Millimetres per second
N	Nitrogen
NaOH	Sodium hydroxide
NH_3	Ammonia
NH_4^+	Ammonium
P	Phosphorus
POME	Palm Oil Mill Effluent
POMSC	Palm Oil Mill Sludge Cake
Ppm	Parts per million
t/ha	Tonne per hectare

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Pumpkin is used mostly in traditional cooking for Malaysian people and it is chosen because of the taste that can increase the appetite. Pumpkin does not have cholesterol and 90% of it is water. It is enriched with beta carotene that can acts as antioxidant which can helps to protect cells body from cancer disease.

Government takes proactive actions to increase the awareness of Malaysians regarding nutrition and benefits that can be obtained from pumpkin. Federal Agriculture Marketing Authority (FAMA) is the main agency that markets the agriculture products and promotes pumpkin to Malaysians so that pumpkin can be used as one of the foods in cooking. FAMA also took the effort to aware people regarding nutrition contents in pumpkin.

Cultivation of pumpkin did not have much problem since the yield can be harvested after 3 months. Terengganu, Kelantan, Perak and Kedah are the main states that cultivate pumpkin which is about 2,000 hectare. In 2004, FAMA gained profit from 2,000 metric ton of pumpkin that has been exported around the world that valued RM 2 thousands. 60 percent of the demands for pumpkin are from wholesaler and the rest is from dealer and individual (Azlani, 2006).

In this study, pumpkin (*Cucurbita maxima* L.) are cultivated on three different soil treatments which are BRIS soil for control, BRIS soil with 22t/ha palm oil mill sludge cake (POMSC) and BRIS soil with 34t/ha POMSC. The POMSC was previously known as POME which is thick brownish viscous liquid waste and non-toxic as no chemicals are added during oil extraction but has an unpleasant odour. POME contains high concentrations of COD, BOD and Organic Suspended Solids. Consequently, many of the systems used to treat the effluent have centred on anaerobic digestion (Chooi, 1984 and Ma, 1999).

The matured pumpkins from different soil treatments were taken and analyzed for the physical characteristics and nutrient compositions. So far, there is no study had been done to check the nutrient compositions of pumpkins cultivated on different soil treatments involving POMSC with BRIS soil. Therefore from this study, we can determine whether different soil treatments can have any significant effect on the nutritional compositions of pumpkin.

1.2 Problem Statement

BRIS soil is low in water holding capacity, low in nutrient content and moisture stress is high. As it is low in water holding capacity, the nutrient from fertilizer cannot be absorb by plant. Thus, to solve this problem is to build up humus in the soil and facilitate nutrient cycling (Byrne, 2003). The uses of POMSC are to help increase the ability of water holding capacity and nutrient in soil. There is no study had been done reported on the nutrient composition of pumpkin using different soil treatments involving POMSC and BRIS soil.

1.3 Significant of Study

The data from this study could be used as a reference for the postharvest quality of pumpkins cultivated on BRIS soil and BRIS soil enriched with POMSC in terms of their physical characteristic and nutritional compositions. Thus, could also give other opportunities and hopes for the farmers to grow more profitable crops on BRIS soil.

1.4 Objectives

The objectives of this study are;

i. To determine the NPK content in different types of soil treatments i.e. BRIS soil, BRIS soil with 22t/ha POMSC and BRIS soil with 34t/ha POMSC

ii. To determine the physical characteristics and nutritional compositions of pumpkin cultivated on different types of soil.

CHAPTER 2

LITERATURE REVIEW

2.1 Pumpkin (*Cucurbita maxima* L.)

Pumpkin (*Cucurbita maxima* L.) is from the genus *Cucurbita* and belongs to the family *Cucubitaceae*. Fruits are globular in shape and are differentiated from marrows by having a somewhat coarse, strong flavoured yellow orange flesh (Purseglove, 1968). Harvesting of pumpkin is carried out when fruit are fully mature and have reached an acceptable size with golden yellow flesh and a good texture.

Pumpkins are a squash-like fruit and since some squash share the same botanical classifications as pumpkins, the names are frequently used interchangeably. In general, pumpkins have stems that are more rigid, pricklier and squarer than squash stems which are generally softer, more rounded and more flared where joined to the fruit. Pumpkins generally weight about 4–8 kg but also capable of reaching a weight of over 34 kg. The pumpkin varies greatly in shape, ranging from oblate through oblong. The rind is smooth and usually lightly ribbed (Wikipedia, 2009).

Pumpkins are monoecious, having both male and female flower on the same plant (Figure 2.2). The female flower is distinguished by the small ovary at the base of the petals. These bright and colourful flowers have extremely short life spans and may only open in a short time for one day. The colour of pumpkins is derived from the orange pigments abundant in them. The main nutrients are lutein, and both alpha and beta carotene that generates vitamin A in the body (Wikipedia, 2009).

Figure 2.1: Pumpkins (*Cucurbita maxima* L.). (A) immature fruit ; (B) mature fruit which is ready to be harvested

Figure 2.2: Monoecious flowers of pumpkin plant. (A) female flower ; (B) male flower

Table 2.1: Nutritional composition of pumpkin (Source: Siong *et al*., 1997)

Nutrients	Content (g/ 100g fresh weight)
Water content	62.47
Protein	0.67
Fat	0.07
Crude fibre	0.22
Ash	0.29
Carbohydrate	10.29

2.2 BRIS soil

BRIS soil has more than 90% of soil that is non fertile in nature. The ability of soil to hold cation and water are low and the composition of organic carbon is less than 1% and with pH less than 5.0 (Table 2.2) make BRIS soil cannot support the growth of plant and can cause decreasing in the plant production (Aminuddin *et al.*, 2007; Wan Zaki *et al.*, 2008). The environment of high temperature will also make it difficult for the plant to grow. BRIS soil still has a potential for agriculture because of the soil topography that is flat and it is easy when using machine.

Table 2.2: Physical and chemical analyses of bris soil at Rhu Tapai (Aminuddin. *et al.*, 1982)

Series of soil horizon and deep		A1/0-17cm	A2/17-35cm
Content (%)	**Rough soil (2-0.2mm)**	62	50
	Smooth soil (0.2-0.02mm)	34	47
	Precipitate	Cause	Cause
	Clay	5	3
Organic carbon %		0.57	0.25
pH		4.3	4.3
***KPK (meq/100g)**		2.7	1.3
***KMA 0.1 bar**		5.1	5.1

*KPK = the ability of cation exchange
*KMA = the ability to hold water

2.3 POMSC (Palm Oil Mill Sludge Cake)

POMSC (Palm Oil Mill Sludge Cake) also known previously as POME is used for cultivation of fruits such as sapodilla and carambola (Aminuddin *et al.*, 2007; Wan Zaki *et al.*, 2008). BRIS soil that mix with POMSC in small hole or layer above the soil was proven could patch the growth of tree such as sapodilla and carambola in the first six month (Aminuddin *et al.*, 2007) while the production of tobacco increase at least two times.

The advantages of using POMSC are it can help to increase the ability of cation exchange, organic carbon content and nutrient in soil. It also can decrease the absorption of nutrient in soil and urge the nutrient available in quantity that needed in cultivation (Wan Zaki *et al.*, 2008). The utilization of POMSC can also decrease the cost of using fertilizer. POMSC can hold nutrient of N, P and K with the rate of 0.5% N, 0.4% P, 0.5% K, 0.8% Ca and 0.3% Mg (Wan Zaki *et al.*, 2008).

POMSC were normally used in wet condition because if POMSC is dry, it does not give a good effect, so POMSC cannot leave uncover directly through the sun to avoid it from dry (Aminuddin *et al.*, 2007).

2.4 Soil Nitrogen, Phosphorus and Potassium (NPK)

Most plants grow by absorbing nutrients from the soil and their ability to do this depends on the nature of the soil. Depending on its location, a soil contains some combination of sand, silt, clay, and organic matter. The makeup of a soil and its acidity (pH) determine the extent to which nutrients are available to plants.

Clays and organic soils hold nutrients and water much better than sandy soils. As water drains from sandy soils, it often carries nutrients along with it, this condition is called leaching. When nutrients leach into the soil, they are not available for plants to use.

Soil pH is a measure of the acidity or alkalinity of the soil. Soil pH is one of the most important soil properties that affect the availability of nutrients. In soil composition, macronutrients tend to be less available in soils with low pH and micronutrients tend to be less available in soils with high pH.

Nitrogen (N) is an essential nutrient for plant growth. Plants take it in large amounts, whereas its concentration in soils is frequently very small. Since soil N is mostly organic in nature, N concentrations in soils increase with high organic matter contents (Kim H.Tan, 1996).

Nitrogen is estimated using Kjeldahl method which oxidizes the organic matter present in the soil and hydrolyses the liberated ammonia which is condensed and absorbed in boric acid and titrated against standard acid. The process of oxidative hydrolysis is progressive one in a uniform time and heating temperature should be allowed for best results (Kim H.Tan, 1996).

Like nitrogen, phosphorus (P) is also an essential part in the process of photosynthesis which involves in the formation of all oils, sugars, starches, etc. Phosphorus cans effects rapid growth, encourages blooming and root growth. Phosphorus often comes from fertilizer, bone meal and superphosphate.

Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and in some cases, calcium. It helps in the building of protein, photosynthesis, fruit quality and reduction of diseases. Potassium is supplied to plants by soil minerals, organic materials and fertilizer (Busman *et al.*, 2002).

2.5 Nutritional Compositions

2.5.1 Water content

Water is one of the essential nutrients to life and we cannot live long without water. There are many ways to get water without having to drink it everyday, plain from the tap or from a store-bought bottle. Fruit and vegetable that has high nutrient value can also be one of the important sources of water. The recommended serving for fruits is about 2 to 4 servings per day and for vegetable are about 3 to 5 servings per day.

Water content is expressed as a percentage of the wet weight of the material. It is used most commonly in the field of solid waste management (Theodore and Theodore, 1996). The examples of fruit with high water content are apples with the weight of 138g/164g fresh weight of sample which has 84% of water. Banana is one of the lowest in water content but with the weights about 114g/154g fresh weight, it consists of 74% water. While, strawberry which is everybody favourite for pie and topping on ice-cream is one of the highest water content with 92%.

2.5.2 Protein

Proteins also known as polypeptides are organic compounds made of amino acids arranged in a linear chain. The amino acids in a polymer chain are joined together by the peptide bonds between the carboxyl and amino groups of adjacent amino acid residues. The sequence of amino acids in a protein is defined by the sequence of a gene, which is encoded in the genetic code (Ridley, 2006).

Vegetables, legumes and fruits are good sources of protein. Generally, legumes have higher content of protein than vegetables and fruits. The advantage of plant protein sources over animal protein is that plant protein sources are low in fat content and high in dietary fibre. In the following table (Table 2.3) is protein content in a few selected produces.

Table 2.3: Protein content of foods (Source: DietaryFiberFood.com 2009)

Proteins sources	Protein content (% of dry matter)
Avocado	10.65
Strawberry, fresh	7.53
watermelon	6.40
banana	5.14
Apple, Red Delicious, peeled	0.32

2.5.3 Fat

Fats consist of a wide group of compounds that are generally soluble in organic solvents and largely insoluble in water. Chemically, fats are generally tri-esters of glycerol and fatty acids. Fats may be either solid or liquid at normal room temperature, depending on their structure and composition (Maton *et al.*, 1993).

Fats form a category of lipid, distinguished from other lipids by their chemical structure and physical properties. This category of molecules is important for many forms of life, serving both structural and metabolic functions. Fats or lipids are broken down in the body by enzymes called lipases produced in the pancreas.

Examples of edible plant fats are peanut, soya bean, sunflower, coconut, olive and vegetable oils. Margarine and vegetable shortening, which can be derived from the above oils, are used mainly for baking. While avocado is very popular in vegetarian cuisine for making a good substitute for meats and cheeses in sandwiches because of the high fat content.

2.5.4 Ash

For most foods, ashing will give acceptable results for trace elements analysis. Losses of minerals due to carbon release can be appreciable from carbon-containing samples. This mechanical loss of ash is avoided by starting the incineration in the muffle furnace at a low temperature (room temperature) and allowing the temperature to rise slowly (Anonymous, 2008)

Inorganic material left over after the food is burned for six hours at 550°C, the remaining residue is the ash. Thus, it does not include water, fibre and nutrients that provide calories but it does include some nutrients such as minerals. This residue consists of oxides and salts containing anions such as phosphates, chlorides, sulphates and other halides and cations such as sodium, potassium, calcium, magnesium, iron and manganese.

2.5.5 Fibre

Dietary fibre is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. It includes polysaccharides, oligosaccharides, lignin and associated plant substances. Dietary fibre promotes beneficial physiological effects including blood cholesterol attenuation and glucose attenuation (Anonymous, 2000).

Natural high level sources of dietary fibre are whole grains, fruits and vegetables. Many of the dietary recommendations regarding dietary fibre focus on consuming foods with high content in dietary fibre because of nutrition experts believe that other components of the food may be contributing to the health benefits along with the dietary fibre. Obviously humans are unable to synthesize dietary fibre internally and must depend on their food for adequate supplies.

Table 2.4: Dietary fiber content of some foods (DeVeries, 2009)

Food	g/100g	FOOD	g/100g
Almond	10-11	Oat Bran	16.5-17.5
Apple (peeled)	1.5-2	Oat Meal	1.5-2.5
Apple (skin on)	2-3	Orange	1.5-2.5
Asparagus	1.5-2	Peanuts	1-2
Banana	1.5-2.5	Potato	1.5-2.5
Broccoli	3-3.5	Spinach	2.0-2.6
Cabbage	1-2.5	Strawberry	1.8-2.3
Cashew	3.4	Tangerine	1.8
Melon cantalope	0.5-1	Walnuts	10-11

2.5.6 Carbohydrate

Carbohydrates are simple organic compounds that are aldehydes or ketones with many hydroxyl groups added, usually one on each carbon atom that is not part of the aldehyde or ketone functional group. The basic carbohydrate units are called monosaccharides such as glucose, galactose and fructose. While the more complex are oligosaccharides and polysaccharides (Matthews *et al.*, 1999).

Foods high in carbohydrates is wheat and carbohydrates require less water to digest than proteins or fats and are the most common source of energy in living things (Pichon *et al.,* 2006). In fruit, the carbohydrates may differ between individual pieces depending on their ripeness and source. Canned fruit often contains more carbohydrate levels than their natural counterparts due to added sugars.

CHAPTER 3

MATERIALS AND METHODS

3.1 Sample Preparation

Six matured pumpkins from each soil treatment were taken from Stesen Komoditi Rhu Tapai. The fruits were cleaned and washed by using distilled water. Then, the samples were left to dry before analysed for physical characteristics, water and ash content. The fruits were de-skinned and cut into small slices and quick-frozen with liquid nitrogen and kept in the -80°C freezer before freeze-dried to obtain fresh dried pumpkin pulp. The dried pumpkin was then ground into powder for proximate analyses of protein, fat, fibre and carbohydrate (AOAC, 1984).

Figure 3.1: Pumpkin pulp (A) Freeze-dried; (B) Grind into powder

Figure 3.2: Six pumpkins from each treatment (A) Bris (control); (B) Bris + 22 t/ha POMSC; (C) Bris + 34 t/ha POMSC

3.2 Soil Analyses

There were four soil samples were collected randomly from the pumpkins planting plots which were:

1) BRIS soil –Control
2) POMSC (pure)
3) BRIS with 22 t/ha POMSC
4) BRIS with 34 t/ha POMSC

The soils were air-dried under the shade (no direct sunlight) for one week. The stones and foreign matters were removed from the soils. The soils were then sieved starting from 200 mesh until 500 mesh to obtained finer soil particles. The sieved soils were then used for analyses of Nitrogen, Phosphorus and Potassium contents.

3.2.1 Nitrogen (N)

Nitrogen was estimated using Kjeldahl method which involves stages of digestion, distillation and titration. For digestion, about 0.1 g dried soil was put into Kjeldahl tube, followed by addition of 0.25 g of potassium sulphate, 20 ml of sulphuric acid and two tablets of Kjeldahl catalyst. The digestion tubes were tightly fixed into the digestion set which have heating digester, acidic gas tapper with water aspiration. The digestion process was done for about two hours until the entire samples turn to light apple green in colour. Once the light green appears, the system is switched off and the digestion tubes are cooled before proceed to the next stage, i.e distillation.

Distillation was done by raising the pH of the samples in Kjeldahl tube with sodium hydroxide. This has the effect of changing the ammonium (NH_4^+) ions which are dissolved in the liquid to ammonia (NH_3), which is a gas. Nitrogen was separate from the digestion mixture by distilling the ammonia and then trapping the distilled vapours in a 60 ml of 2% boric acid that had been added with one drop of methyl red indicator.

Then, the boric acid in conical flask was titrated with a standard solution of 0.1M HCl. The amount of ammonia distilled off from the digestive solution was calculated and the amount of nitrogen was determined by using the following formula:

$$\% N = \frac{14 \times \text{vol of HCl (ml)}}{\text{Sample wt (g)}} \times \frac{\text{concentration of HCl (M)}}{1000 \text{ ml}} \times 100$$

3.2.2 Phosphorus (P) and Potassium (K)

Phosphorus and potassium was estimated by using inductively coupled plasma (ICP) in closed digestion (Ethos plus Microwave Labstation). About 1g of soil sample was weighed in closed digestion flask. Then, 8 ml of concentrated nitric acid (HNO_3), 5 ml of hydrochloric acid (HCl), 2 ml of hydrofluoric acid (HF) and 10 ml of 5 % boric acid (H_3BO_3) was added into the flask and the soil samples was digested in closed digestion for about two hours.

After two hours, the soil sample was taken out and cooled before it was filtered and diluted with 50ml of deionised water. The diluted samples were then analysed by using ICP with the standard solution of 2 ppm, 6 ppm, 10 ppm, 30 ppm and 50 ppm.

3.3 Physical Characteristics

3.3.1 Skin and pulp colour

The colour of pumpkin skin and pulp were measured using L*, a* and b* Minolta Chromameter (CR 400, Minolta Camera). For skin colour, L* a* b* were measured at three different sites which were on top, middle and bottom of fruit for all the six samples of pumpkins cultivated on each soil treatment. While for flesh colour, pumpkin was cut into half and the L* a* b* were measured at 3 different sites on each half and repeated on another six fruits for every soil treatment.

3.3.2 Pulp texture

The fruit was cut into half and the firmness of the fruit pulp was determined by using Texture Analyser TAX.Tplus (Stable Macro System) using P/5 stainless steel cylinder probe. The testing parameters used were as below;

Test mode : Compression

Pre-test speed : 1.0 mm/sec

Test speed : 0.5 mm/sec

Post test speed: 10 mm/sec

Distance : 10.0 mm

The maximum positive values (firmness) for each test were recorded. Texture tests were run 6 times on each fruit (3 different sites on each half) and done on each six fruits for every soil treatment.

3.3.3 Weight and size

All the six fruits from each treatment were weighted by using top pan balance and their weights were recorded in kilogram. The size of each fruit was measured by using thread and ruler. The size for longitudinal perimeter was measured from the stem end to end stem around the fruit passing through the bottom end of the fruit while for latitudinal perimeter was measured around the equatorial of the fruit.

3.4 Proximate Analyses

3.4.1 Water content and dry matter

5g of the pumpkin was cut into small pieces and place inside a drying oven at 105°C. The sample was heated for at least 3 hours or until its dry weight was constant. Then, the sample was allowed to cool in a desiccator before it can be re-weighted. The initial and final weights after drying were recorded by using the following formula:

$$\%\ \text{water content} = \frac{\text{Initial} - \text{Final}}{\text{Initial}} \times 100$$

$$\%\ \text{dry weight} = 100 - \%\ \text{water content}$$

3.4.2 Protein

Protein content in pumpkin were determined by using Kjeldahl method which involves three stages, digestion, distillation and titration as was described in section

3.2.1 and the sample of dried pumpkin flesh was used is 0.5 g. In calculating the protein content of food, the percentages of nitrogen was converted to protein by multiplying the factor of 6.25, using the following formula:

$$\% \mathrm{N} = \frac{14 \times \text{vol of HCl (ml)}}{\text{Sample wt (g)}} \times \frac{\text{concentration of HCl (M)}}{1000\,\text{ml}} \times 100$$

$$\% \text{ Protein} = \% Nitrogen \times 6.25$$

3.4.3 Fat

The fat content was determined by directly extracting 2 g of dried pumpkin flesh by using Manual Extraction System-Soxtec Avanti 2055 extractor. The fat from the sample was extracted using hexane as the solvent. This process involved three steps which were extraction, rinsing and drying. The residue in round bottom flask after solvent removal represents the fat content of the sample.

3.4.4 Ash

The preparation of ash was the same as preparing sample for moisture content. 5g of sample was place into crucible and weights were recorded. Then, the samples were placed into a furnace (Muffle furnace 62700) for 6 hours at 550°C until a white residue of constant weight was obtained. The cooled samples were then re-weighted.

3.4.5 Fibre

Crude fibre of sample was determined by using Fibertec System 2021 FibreCap, after chemical digestion and solubilisation of other materials present. 2g of dried samples were weighted into capsule and then the samples were then boiled in 350 ml of 1% HCl for about 20 minutes. After boiling with HCl, the samples were rinsed with 350 ml hot boiling distilled water for two times. Then, the samples were boiled with NaOH and rinsed with hot boiling distilled water again.

After that, the samples were dried in an oven (Multipurpose oven microprocessor) for 5 hours at 105°C. The samples were cooled in dessicator and the weigh was recorded. The fibre content was determined by finding the percentage of residue weight in the crucible.

3.4.6 Carbohydrate

Carbohydrate content was determined by the difference between the moisture, protein, fat, fibre and ash percentages (Ferris *et al.*, 1995). The sum of the percentages of moisture, protein, fat, fibre and ash was subtracted from 100 to determine the percentage of carbohydrate in the sample.

$$\% \text{ CHO} = 100 - (\text{moisture} + \text{protein} + \text{fat} + \text{fibre} + \text{ash}$$

3.5 Statistical Analyses

The data obtained from the physical characteristics and proximate analyses of pumpkin for each soil treatments were analysed by using one-way ANOVA. The significant differences ($P < 0.05$) between treatments were determined using Tukey test and the statistical programme used was SPSS.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Soil Analyses (NPK)

4.1.1 Nitrogen

N promotes rapid growth (increased plant height and number of tillers), increased leaf size and protein content (Brandon and Wells, 1986). From Table 4.1, nitrogen content in soil samples of POMSC is the highest followed by BRIS soil with 34t/ha POMSC, BRIS with 22t/ha POMC and BRIS control.

4.1.2 Phosphorus

Phosphorus is mobile within the plant and promotes tillering, root development, early flowering and ripening. It is particularly important in early growth stages (De Datta, 1981). From the result, P content is highest in POMSC, followed by BRIS soil with 34 t/ha POMS, BRIS soil with 22t/ha POMSC and the lowest phosphorus content is BRIS control.

4.1.3 Potassium

Potassium provides strength to plant cell wall, increase leaf area and leaf chlorophyll content and delays leaf senescence. It also improves plant's tolerance of adverse climatic conditions, lodging, insect pests and diseases. For K content, POMSC is the highest followed by BRIS with 34 t/ha POMSC, BRIS with 22 t/ha POMSC and BRIS control.

Table 4.1: Analyses of soils in cultivation of pumpkins (%)

Soil samples	N	P	K
BRIS	0.35	$5.93x10^{-4}$	$2.46x10^{-4}$
BRIS + 22 POMSC	0.49	$1.47x10^{-3}$	$3.23x10^{-4}$
BRIS + 34 POMSC	0.56	$2.77x10^{-3}$	$7.17x10^{-4}$
POMSC	0.63	$2.00x10^{-2}$	$3.43x10^{-3}$

Overall, POMSC has the highest N, P and K content so it is suitable to be used for enrichment in cultivation of crop besides helping to improve the soil. POMSC can also decrease cost of using fertilizer and can hold nutrient of N, P and K with the rate of 0.50% N, 0.40% P, 0.50% K, 0.80% Ca and 0.30% Mg (Wan Zaki *et al.*, 2008).

4.2 Physical Characteristics

4.2.1 Skin Colour

Lightness value, L*, indicates how dark/light the sample is which are varying from 0-black to 100-white, a* is a measurement of greenness/redness which is varying from 60 to +60 and b* is the grade of blueness/yellowness which is also varying from 60 to +60.

As fruit matures and ripens, colour changes from green to red or yellow. Red colour in fruits depends on exposure to light, therefore the position of the individual fruit will greatly affect the development of the red pigment in the skin. Excessive quantities of nitrogen can also have a deleterious effect on skin colour as well as internal and keeping quality. Change in background colour of the fruit is not affected by sunlight and thus is a more dependable measure of maturity. The most common method of assessing fruit readiness to harvest, skin colour is not considered the most accurate indicator of maturity. However, experienced growers often use background colour as a means of assessing harvest maturity (Lill *et al.*, 1989).

The L* a* b* value of pumpkins from each soil treatments were slightly different (Figure 4.1 and table 4.2). L* value of pumpkins which cultivated on BRIS soil with 34t/ha POMSC was the highest, followed by pumpkin from BRIS soil with 22t/ha POMSC and the lowest is pumpkin cultivated on BRIS soil control. For a* value, pumpkin from BRIS soil treatment has the highest a* value, followed by pumpkin from soil treatment of BRIS soil with 34 t/ha POMSC and pumpkin from soil treatment of BRIS soil with 22t/ha POMSC. While for b* value, pumpkin from BRIS soil with 34t/ha POMSC is the highest followed by pumpkin from soil treatment of BRIS soil control and the lowest is pumpkin from BRIS soil with 22t/ha POMSC.

There was no significant different ($P>0.05$) for skin colour value of L* a* and b* among treatments on BRIS soil control, BRIS soil with 22 t/ha POMSC and BRIS soil with 34t/ha POMSC.

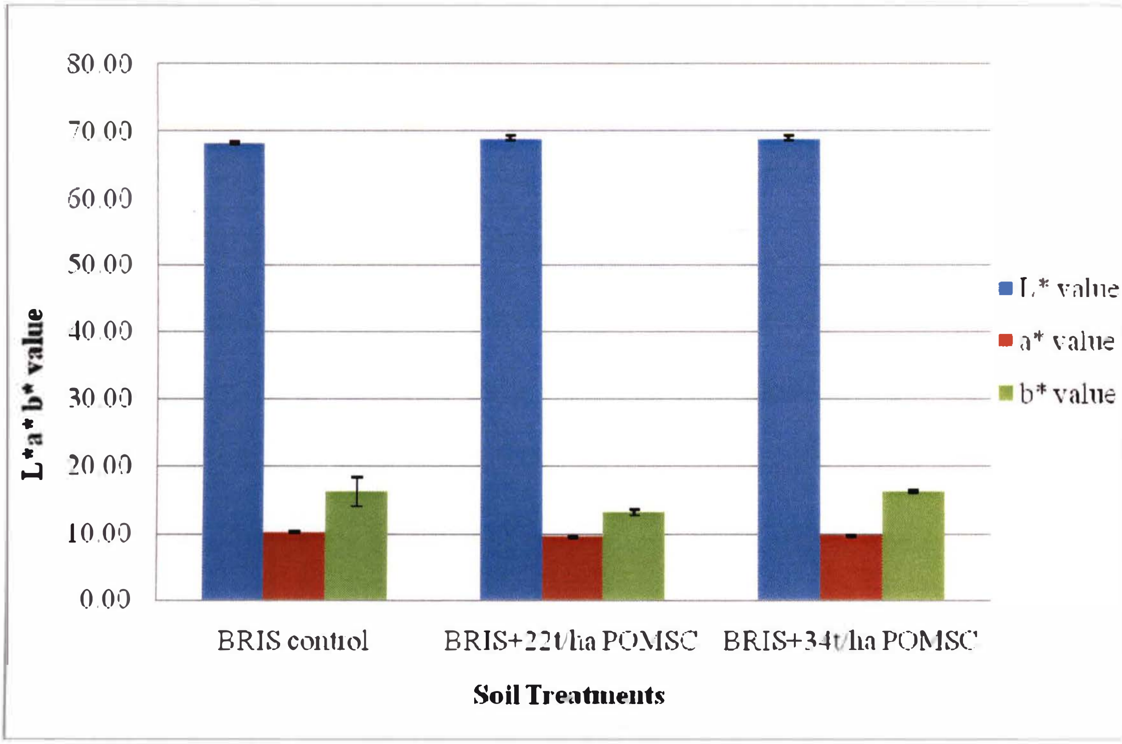

Figure 4.1: The skin colour (L*a*b*) of pumpkins cultivated on different soil treatments.

Table 4.2: The skin colour (L*a*b*) of pumpkins cultivated on different soil treatments.

Treatment		**Skin colour**	
	L* value	**a* value**	**b* value**
BRIS soil	66.25[a]	10.27[a]	16.23[a]
BRIS soil + 22 t/ha POMSC	69.02[a]	9.50[a]	13.24[a]
BRIS soil + 34 t/ha POMSC	68.95[a]	9.72[a]	16.27[a]

4.2.2 Pulp colour

The pulp colour of pumpkin also showed that the L* a* b* values were slightly different (Figure 4.2 and table 4.3) from each soil treatments. The L* value of pumpkin pulp from BRIS soil with 34t/ha POMSC was the highest, followed by pumpkin from BRIS soil with 22 t/ha POMSC and the lowest is from BRIS soil control. For a* value, pumpkin with BRIS soil treatment has the highest a* value, followed by pumpkin with treatment on BRIS soil with 22t/ha POMSC and pumpkin with treatment on BRIS soil with 34 t/ha POMSC. While for b* value, pumpkin from BRIS soil with 22t/ha POMSC is the highest followed by BRIS soil treatment and the lowest is from BRIS soil with 34t/ha POMSC.

There was no significant different (P>0.05) for pulp colour value of L* among all soil treatments. For a* value, there was significant different between BRIS soil control and BRIS with 22t/ha POMSC and between BRIS soil control and BRIS with 34t/ha POMSC. While for b* value of pulp colour, there was no significant different (P>0.05) among treatments on BRIS soil control, BRIS soil with 22 t/ha POMSC and BRIS soil with 34t/ha POMSC.

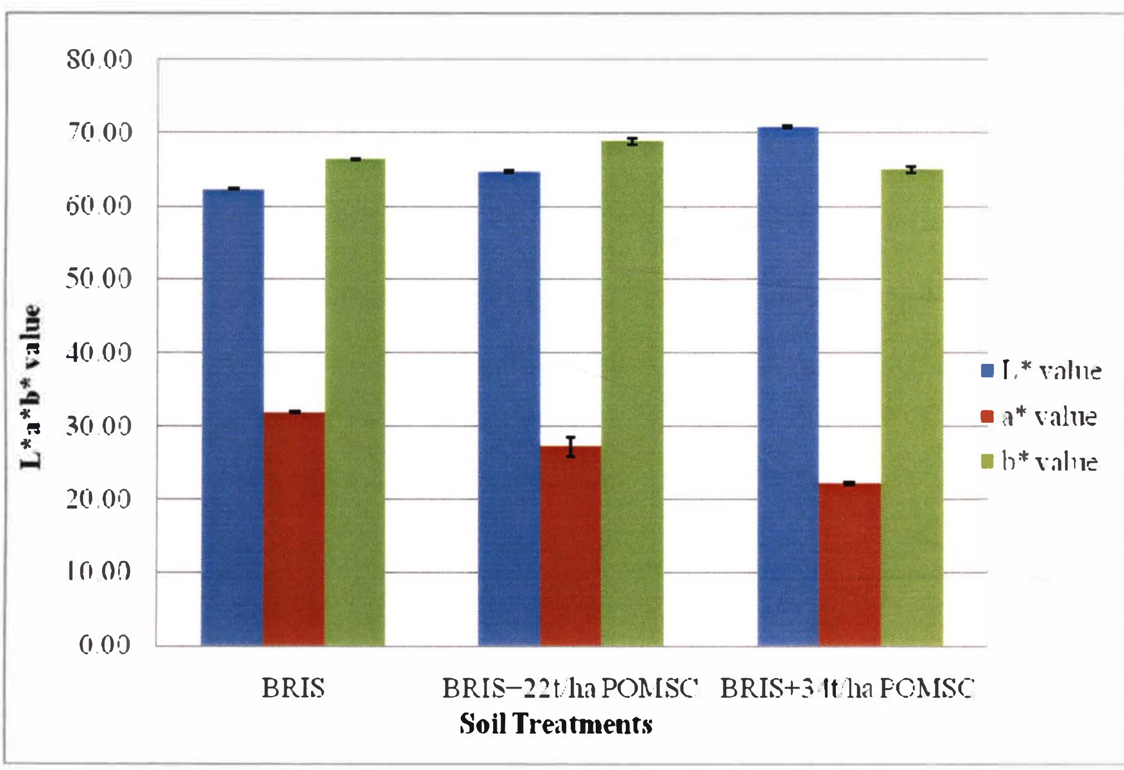

Figure 4.2: The pulp colour (L*a*b*) of pumpkins cultivated on different soil treatments.

Table 4.3: The pulp colour (L*a*b*) of pumpkins cultivated on different soil treatments.

Treatment	Pulp colour		
	L* value	**a* value**	**b* value**
BRIS soil	62.24[a]	31.86[a]	66.45[a]
BRIS soil + 22 t/ha POMSC	64.68[a]	27.25[b]	68.88[a]
BRIS soil + 34 t/ha POMSC	70.86[b]	22.17[a]	65.03[a]

4.2.3 Pulp texture

The ripening process for each fruits on different soil treatments during the experiments varied, and thus different firmness ranges were obtained for each soil treatments. As the fruit ripen, the flesh becomes softer so the firmness will decrease when the stages of maturity increase, the firmness will decrease due to ripening process.

Figure 4.3 and Table 4.4 showed that the firmness of pumpkins was highest in treatment on BRIS soil with 34t/ha POMSC and the lowest on treatment BRIS soil control. Significant different ($P<0.05$) among treatment on BRIS soil control, BRIS soil with 22 t/ha POMSC and BRIS soil with 34t/ha POMSC were also observed.

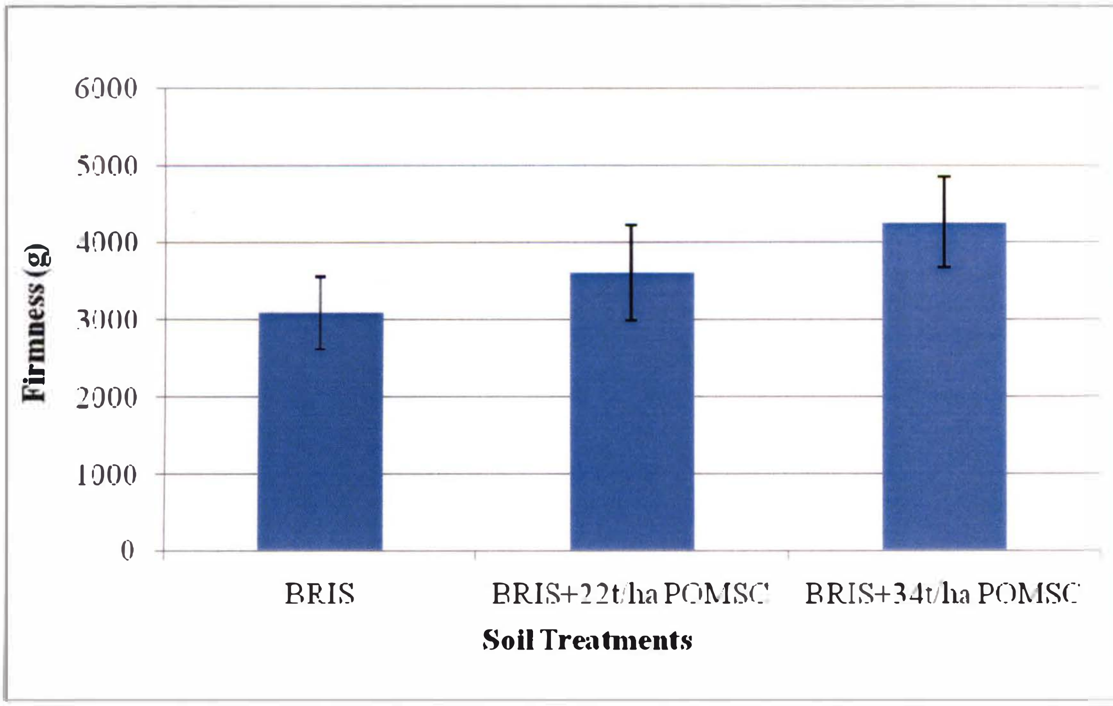

Figure 4.3: The firmness of pumpkins cultivated on different soil treatments.

Table 4.4: The firmness of pumpkins cultivated on different soil treatments.

Treatment	Firmness
BRIS soil	3086.29[a]
BRIS soil + 22 t/ha POMSC	3613.39[ab]
BRIS soil + 34 t/ha POMSC	4260.77[b]

4.2.4 Weight

From Figure 4.4 and Table 4.5, the weights of pumpkins were heavier from BRIS soil control followed by treatment on BRIS soil with 22t/ha POMSC and treatment on BRIS soil with 34t/ha POMSC. Pumpkin cultivated on BRIS soil control is the heaviest due to less number of pumpkins per plant. Significant different ($P<0.05$) among treatment on BRIS soil control, BRIS soil with 22 t/ha POMSC and BRIS soil with 34t/ha POMSC were also observed.

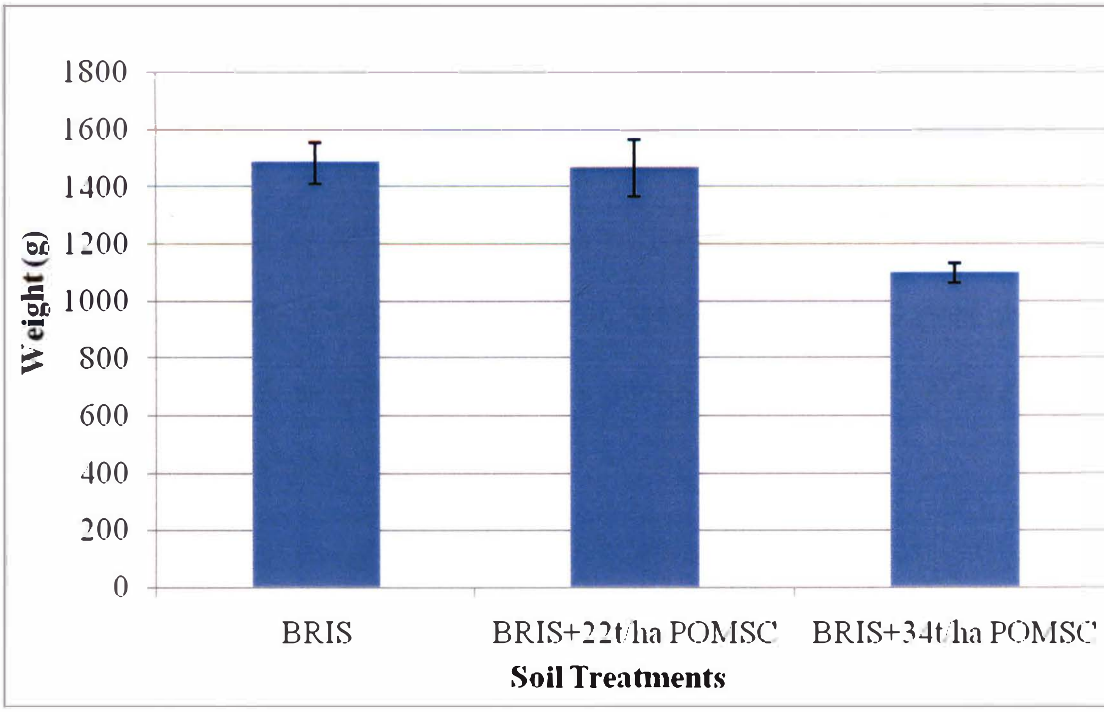

Figure 4.4: The weight of pumpkins cultivated on different soil treatments.

Table 4.5: The weight of pumpkins cultivated on different soil treatments

Treatment	Weight (g)
BRIS soil	1484.97^{a}
BRIS soil + 22 t/ha POMSC	1466.52^{ab}
BRIS soil + 34 t/ha POMSC	1095.97^{b}

4.2.5 Size

Figure 4.5 and Table 4.6, the measurement for longitudinal girth and latitudinal girth, showed that pumpkins which were cultivated on BRIS soil control gave the largest size followed by treatment of pumpkin on BRIS soil with 22 t/ha POMSC and BRIS soil with 34 t/ha POMSC. Pumpkin from BRIS soil with 34 t/ha POMSC is the smallest because the no of pumpkin per plant are too many due to adequate nutrient.

The pumpkins from BRIS soil control was significantly ($P<0.05$) larger compared to pumpkins cultivated on BRIS soil with 22 t/ha POMSC and BRIS soil with 34t/ha POMSC for both longitudinal girth and latitudinal girth length. This is due to the number of fruits per plant for pumpkin on BRIS soil control was lesser than BRIS soil with 22t/ha POMSC and BRIS with 34t/ha POMSC. The more number of fruits on a plant the smaller the fruit sizes due to the distribution or rationing of nutrients among the fruits.

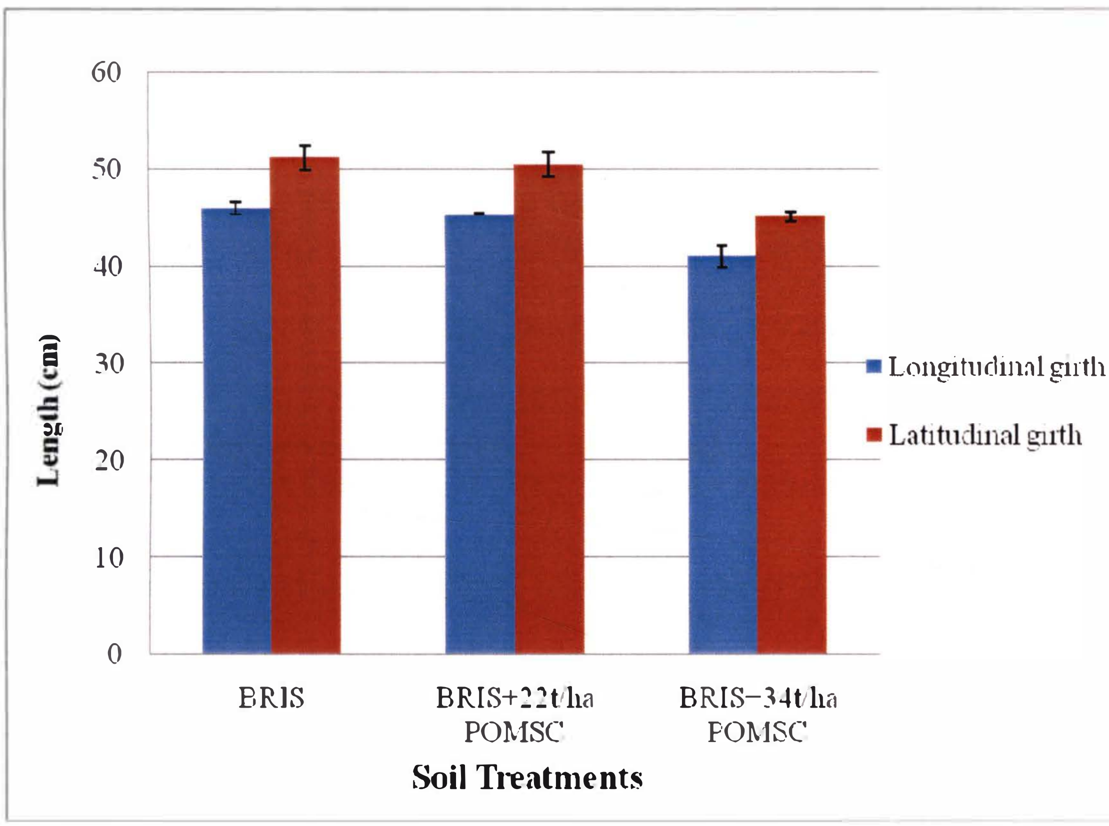

Figure 4.5: The size of pumpkins cultivated on different soil treatments.

Table 4.6: The size of pumpkins cultivated on different soil treatments.

Treatment	Size (cm)	
	Latitudinal	**Longitudinal**
BRIS soil	51.20^{b}	46.00^{b}
BRIS soil + 22 t/ha POMSC	50.52^{ab}	45.42^{ab}
BRIS soil + 34 t/ha POMSC	45.13^{a}	45.41^{a}

4.3 Proximate Analyses (Chemical compositions)

After all the physical characteristics were done, pumpkins from each treatment were sliced and freeze dried to determine the nutritional compositions in the pumpkin from soil treatment. The nutritional compositions of pumpkin for each soil treatments were shown in Table 4.7. Pumpkin from BRIS soil control contained 84.16 % moisture, 1.00 % ash, 0.29 % fat, 0.41 % protein, 0.16 % fibre and 14.00 % carbohydrate.

Table 4.7: Nutritional composition of pumpkin on different soil treatments

Treatment	Proximate Analyses (%)					
	Water	Protein	Fat	Ash	Fibre*	Carbohydrate#
BRIS soil	84.16[a]	0.41[a]	0.29[ab]	1.00[a]	0.16	14.00
BRIS soil + 22 t/ha POMSC	83.61[a]	0.93[ab]	0.36[b]	1.71[b]	0.11	13.29
BRIS soil + 34 t/ha POMSC	83.90[a]	1.81[b]	0.22[a]	0.93[a]	0.20	12.77

*Two replicate for each treatment (value of an average)
the value was obtain from 100% - (water + ash + fat + protein + fibre)

Meanwhile pumpkin from BRIS soil with 22 t/ha POMSC contained 83.61 % moisture, 1.71 % ash, 0.36 % fat, 0.93 % protein, 0.11 % crude fibre and 13.29 % carbohydrate. While pumpkin from BRIS soil with 34 t/ha POMSC, contained 83.93 % moisture, 0.93 % ash, 0.22 % fat, 1.81 % protein, 0.20 % fibre and 12.77 % carbohydrate.

There was no significant different (P>0.05) for water content found in the pumpkins from different soil treatments but significant different for fat and ash. While for fibre and protein content, treatment of pumpkin from BRIS soil with 34 t/ha POMSC was higher in fibre content and treatment of pumpkin from BRIS soil was higher in carbohydrate.

4.3.1 Water content

The main function of water is that to support animal and plant life. Because most foods originate from living matter, water is also a primary component in many foods. The acceptable level of moisture varies in different food products and a change in this amount can have serious effects on product quality (Pyper, 1985).

Water content in fruits and vegetables can be one of the important sources of water in daily uptake. From figure 4.6, water content of pumpkin with treatment on BRIS soil with 22t/ha POMSC is more than pumpkin that is cultivated on BRIS soil control and BRIS soil with 34t/ha POMSC. From table 4.7, there was no significant different for water content among all soil treatments.

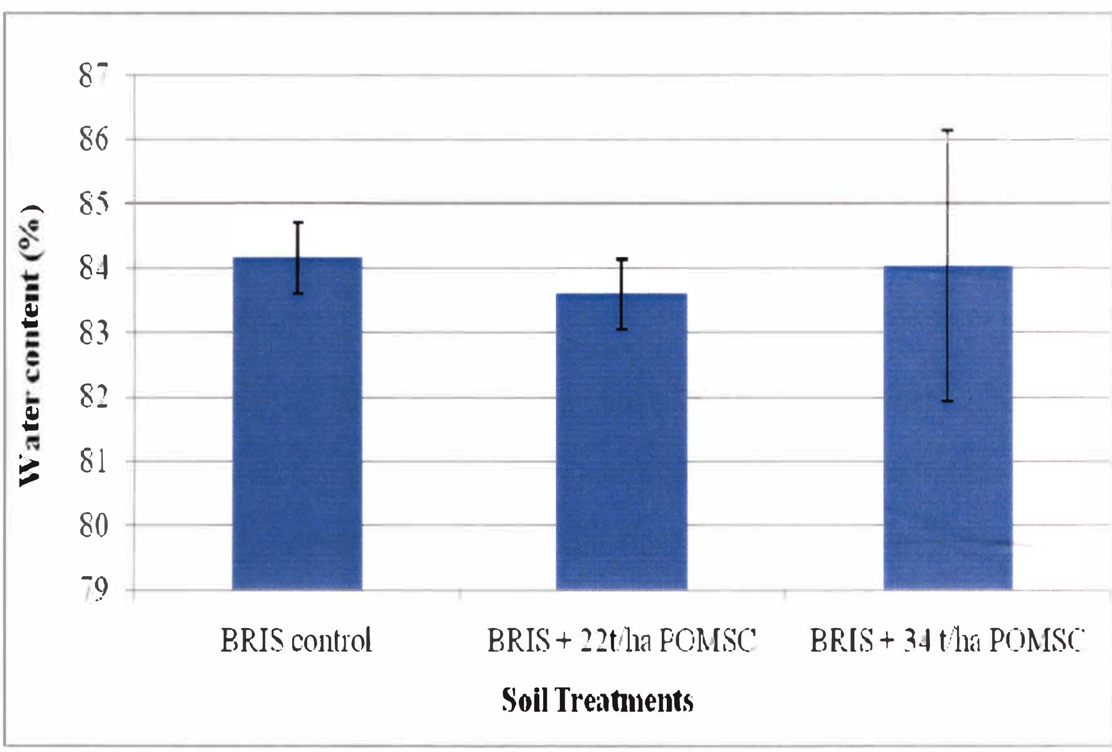

Figure 4.6: The water content of pumpkins cultivated on different soil treatments.

4.3.2 Protein content

Proteins have various biological functions in plants and animals. They build up the structures of the organisms and used as antifreeze protection and nitrogen storage. The proteins that are present in foods in the largest amounts are those that serve as the building material of the muscles, skeleton and skin of animals and as the storage proteins in plants (Sikorski, 2001).

The ability of proteinaceous products to retain water is mainly affected by the protein structures. In food products, the state of water depends on various interactions of water structures with proteins and other solutes. Furthermore, because of the fibrous nature of the muscles and compartmentation caused by different membranes, water is also held in the food product by physical entrapment (Sikorski, 1997).

In this experiment, the percentage of protein was calculated using the standard procedure of Kjeldahl methods and the conversion factor was 6.25. The result of this analysis showed that protein content for each soil treatments are 1.81 % from BRIS soil with 34t/ha POMSC, 0.93 % from BRIS soil with 22t/ha POMSC and 0.41 % from BRIS soil control.

Nitrogen was the most distinguishing element present in proteins. Figure 4.7 and table 4.7 showed that percentage of protein from BRIS soil with 34t/ha POMSC was higher than from BRIS soil with 22t/ha POMSC and from BRIS soil control because the pumpkin from BRIS soil with 34t/ha POMSC has more nitrogen presented rather than the other soil treatments. Protein content in pumpkin from BRIS soil control is the lowest because the soil structure that is low inherent soil status, poor nutrient and water holding capacities, excessive drainage and a very high moisture stress which led to pumpkin from BRIS soil control lack of nutrient especially protein.

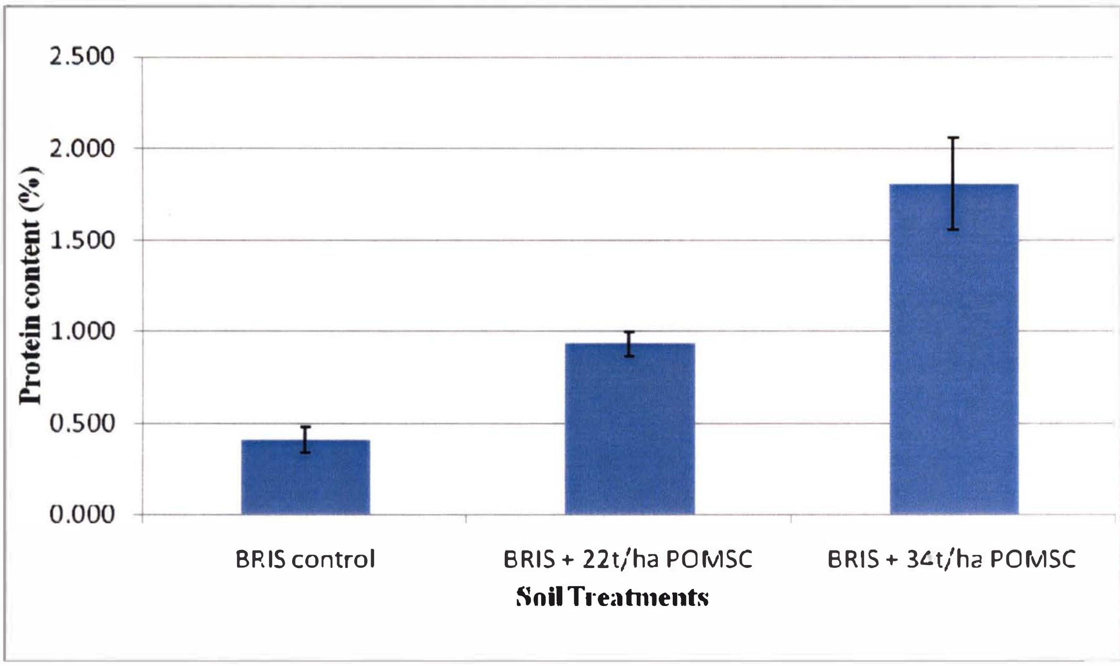

Figure 4.7: The protein content of pumpkins cultivated on different soil treatments.

4.3.3 Fat content

Lipids, proteins and carbohydrates constitute the principle structural component of foods. Lipids that are solid in room temperature are called fats. Fats are a group of substances that in general are soluble in organic solution but insoluble in water. Fats are mainly triacyglycerols (>95%) accompanied by diacyglycerols, monoacyglycerols and free fatty acids.

To determine the fat content, the Soxhlet method was applied which involved a direct solvent extraction. The free lipid content consists of neutral fats (triglycerides) and free fatty acids were determined by extracting the dried and ground material of pumpkin with n-hexane in a continuous extraction apparatus of Soxtec Avanti 2055 extractor. The result for the fat content showed that, pumpkin cultivated from BRIS soil with 22t/ha POMSC was significantly higher followed by BRIS soil control and BRIS soil with 34t/ha POMSC.

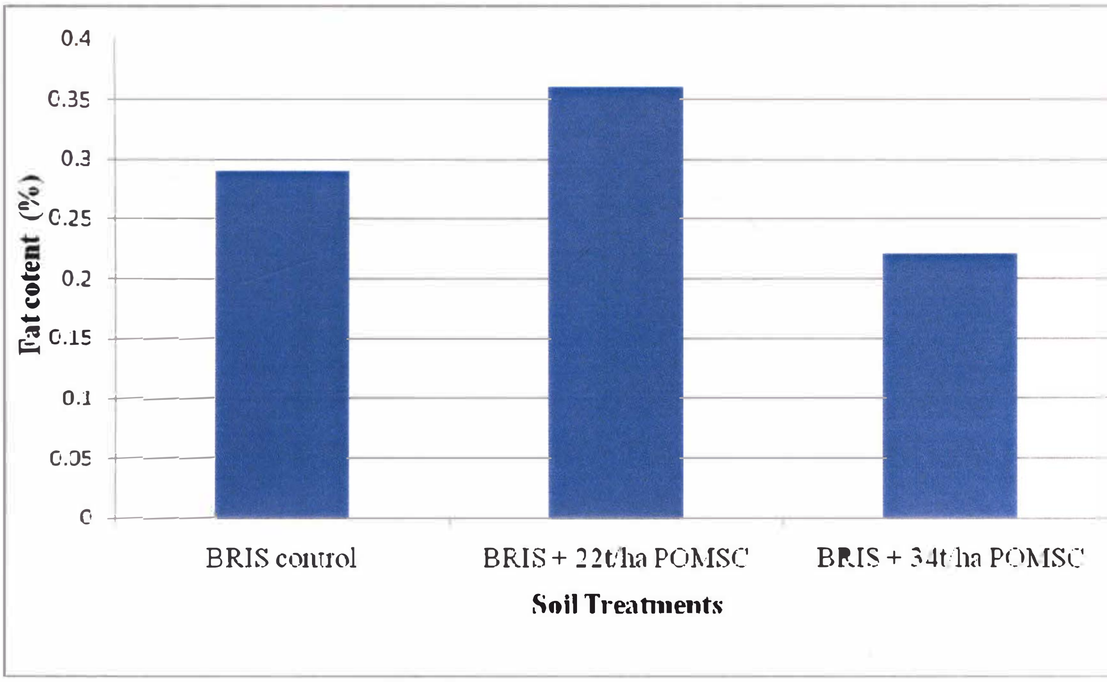

Figure 4.8: The fat content of pumpkins cultivated on different soil treatments.

4.3.4 Ash content

Ash is inorganic residue remaining after total incineration of organic matter. The ash obtained does not typically convert into a different molecular structure such as oxide, phosphates and sulphates. Some minerals may be lost due to volatilization. The ash content can be regarded as a general indicator of product quality. For example, high ash content in sugar, starch or gelatine typically indicates a lower quality of product (Pomeranz *et a*l., 1994).

From figure 4.7 and table 4.7, showed that the ash content in pumpkin was higher from BRIS with 22t/ha POMSC and lowest ash content was from BRIS with 34t/ha POMSC. There were significantly different ($P<0.05$) among each soil treatments.

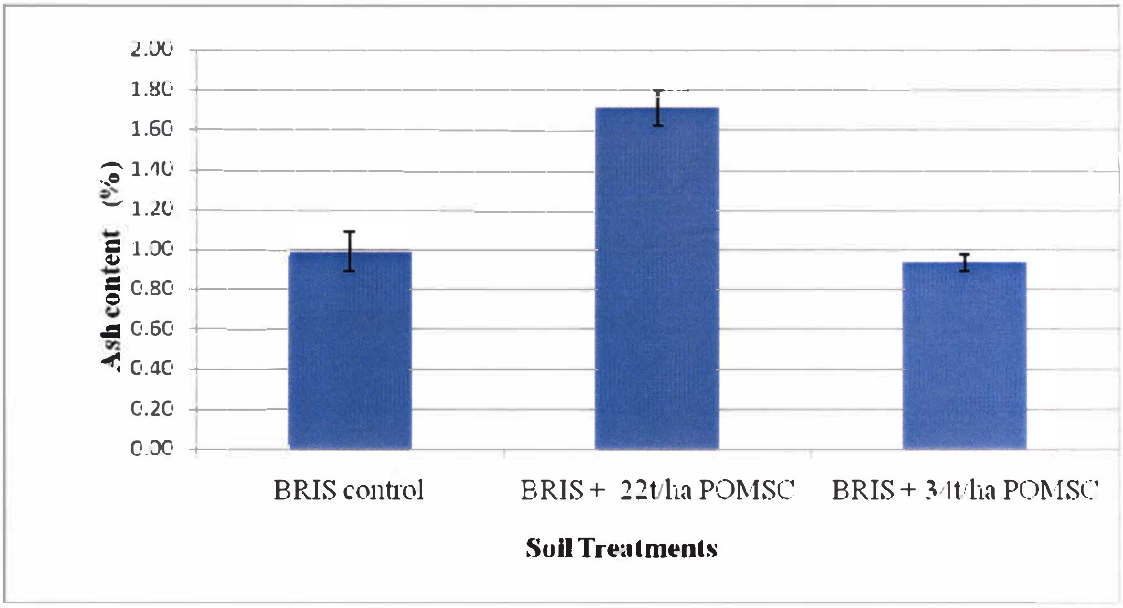

Figure 4.9: The ash content of pumpkins cultivated on different soil treatments.

4.3.5 Fibre content

Dietary fibre includes and comprises of intrinsic plan cell wall polysaccharides which are resistant to digestion and absorption in the human small intestine but which nevertheless promote beneficial physiological effects including blood cholesterol (AACC, 2001).

The differences between the dietary fibre values are mainly due to the amount of starch which remained in the fibre residues and the actual amount varies with the sample and method (Mongeau and Brassard, 1994). Fibre addition to foods is an alternative to compensate for the existent deficiency in the diet. Apart from the nutritional purpose, fibre can be used for technological purposes as bulking agent or fat substitute (Guillon and Champ, 2000).

Fibre content analysis was done in two replicate and analysed by an average data. From table 4.7, fibre content is highest from BRIS soil with 34 t/ha POMSC and the lowest is pumpkin cultivated from BRIS with 22 t/ha POMSC (Figure 4.9). The fibre content for treatment with more POMSC show more increase in fibre content as it can help the growth of pumpkin. BRIS soil that mix with POMSC in small hole or layer above the soil is proven that it function to patch the growth of tree such as sapodilla and carambola in the first six month, (Aminuddin *et al.*, 2007) while the production of tobacco increase at least two times.

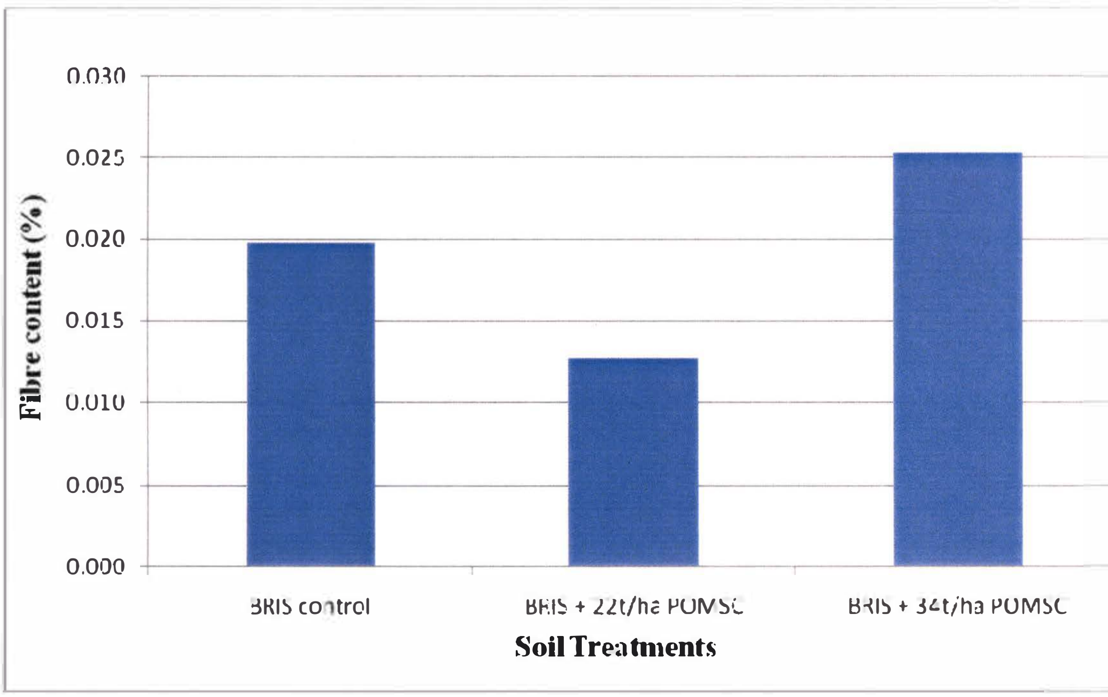

Figure 4.10: The fibre content of pumpkins cultivated on different soil treatments.

4.3.6 Carbohydrates content

From table 4.7, carbohydrate content in pumpkin from BRIS soil treatment is higher followed by BRIS soil with 22t/ha POMSC and BRIS soil with 34t/ha POMSC. The carbohydrate content is response to other nutritional value as it component is related. Fruits are rich in nutrition value compared to vegetables and it is one of the sources of carbohydrates. There are three types of carbohydrates which are sugar, fibre and starch. Sugar is a carbohydrate which is found in fruits. Another form of carbohydrate seen in fruits is dietary fibre which is very beneficial for our health. Physiological effects of starch and dietary fibre is similar but starch is determined by measuring the water uptake or loss when starch is exposed to various relative humidity and temperature.

Carbohydrates also require less water to digest than proteins or fats and are the most common source of energy in living things. Proteins and fat are necessary building components for body tissue and cells, and are also a source of energy for most organisms.

CHAPTER 5

CONCLUSION

5.1 Conclusion

From this experiment, it was found that the physical characteristics and nutritional compositions of pumpkins cultivated on different types of soil treatments were significantly different in BRIS soil control, BRIS soil with 22t/ha POMSC and BRIS soil with 34t/ha POMSC. Pumpkin that cultivated on BRIS soil with 34t/ha POMSC had higher nutritional composition with 83.9 % water, 1.81 % protein, 0.22 % fat, 0.93 % ash, 0.20 % fibre and 12.77 % carbohydrate (Table 4.7). BRIS soil with 34t/ha POMSC also provides adequate amount of NPK content to the cultivation of pumpkin so it has higher value of nutrition and the production of fruits per plant also increase compared to BRIS soil with 22t/ha POMSC and BRIS soil.

Physical characteristic of pumpkin is smaller from BRIS soil with 34t/ha POMSC compared to BRIS soil control because the number of fruits produced on each crops are more compared to BRIS soil control. Pumpkin from BRIS soil control is larger because number of fruits per plant was lesser and therefore each fruit can grow larger but the nutritional value are significantly lesser compared to BRIS soil with 34t/ha POMSC.

The NPK content in different types of soil treatments which are BRIS soil, BRIS soil with 22t/ha POMSC and BRIS with 34t/ha POMSC showed that NPK content in BRIS soil with 34tan/ha POMSC has the highest value of NPK. From the result of soil analyses cultivation of pumpkin, POMSC has the highest NPK content. Hence, it was proven that POMSC has higher NPK content and from the cultivation of pumpkin that was applied with POMSC, treatment of 34t/ha POMSC on BRIS soil was better for cultivation as the nutritional composition of pumpkin is higher compared to BRIS soil control and BRIS soil with 22t/ha POMSC.

5.2 Suggestions

For further study, this experiment would be much better if done starting from pre-harvest of pumpkin till post harvest for more understanding on the cultivation of pumpkin from different soil treatments. Besides that, other parameters such as Total Soluble Solid (TSS) and Titratable Acidity (TA) can also be measured.

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APPENDICES

APPENDIX A: The skin colour (L* a* b*) of pumpkins cultivated on different soil treatments

Treatment	Skin colour		
	L* value	a* value	b* value
Bris soil	66.25±1.84[a]	10.27±0.58[a]	16.23±5.06[a]
Bris soil + 22 t/ha POMSC	69.02±1.62[a]	9.50±0.90[a]	13.24±1.67[a]
Bris + 34 t/ha POMSC	68.95±1.89[a]	9.72±0.86[a]	16.27±3.18[a]

Data shown are the means of six replicate ± standard deviation.
*means separation followed by the same letter within the same column are not significantly difference at 5% level (P<0.05) according to the Tukey test

APPENDIX B: The pulp colour (L* a* b*) of pumpkins cultivated on different soil treatments

Treatment	Pulp colour		
	L* value	a* value	b* value
Bris soil	62.24±0.62[a]	31.86±1.68[a]	66.45±1.48[a]
Bris soil + 22 t/ha POMSC	64.68±2.98[a]	27.25±6.35[ab]	68.88±2.14[a]
Bris + 34 t/ha POMSC	70.86±1.06[b]	22.17±1.45[a]	65.03±4.82[a]

Data shown are the means of six replicate ± standard deviation.
*means separation followed by the same letter within the same column are not significantly difference at 5% level (P<0.05) according to the Tukey test

APPENDIX C: The firmness of pumpkins cultivated on different soil treatments.

Treatment	Firmness
Bris soil	3086.29±647.74[a]
Bris soil + 22 t/ha POMSC	3613.39±431.78[ab]
Bris + 34 t/ha POMSC	4260.77±828.04[b]

Data shown are the means of six replicate ± standard deviation.
*means separation followed by the same letter within the same column are not significantly difference at 5% level ($P<0.05$) according to the Tukey test

APPENDIX D: The weight of pumpkins cultivated on different soil treatments

Treatment	Weight
Bris soil	1484.97±272.00[a]
Bris soil + 22 t/ha POMSC	1466.52±265.63[ab]
Bris + 34 t/ha POMSC	1095.97±219.30[b]

Data shown are the means of six replicate ± standard deviation.
*means separation followed by the same letter within the same column are not significantly difference at 5% level ($P<0.05$) according to the Tukey test

APPENDIX E: The size of pumpkins cultivated on different soil treatments.

Treatment	Size	
	Latitudinal	Longitudinal
Bris soil	51.20±3.47[b]	46.00±3.48[b]
Bris soil + 22 t/ha POMSC	50.52±5.31[ab]	45.42±2.14[ab]
Bris + 34 t/ha POMSC	45.13±1.83[a]	45.41±3.04[a]

Data shown are the means of six replicate ± standard deviation.
*means separation followed by the same letter within the same column are not significantly difference at 5% level ($P<0.05$) according to the Tukey test

APPENDIX F: Nutritional composition of pumpkin

Treatment	Water	Protein	Fat	Ash
Bris soil	84.16±2.14[a]	0.41±0.20[a]	0.29±0.02 [ab]	1.00±0.25[a]
Bris soil + 22 t/ha POMSC	83.61±1.84[a]	0.93±0.27[ab]	0.36±0.00[b]	1.72±0.63[b]
Bris soil + 34 t/ha POMSC	84.04±4.88[a]	1.81±0.66[b]	0.22±0.06[a]	0.93±0.16[a]

Data shown are the means of three replicate ± standard deviation.
*means separation followed by the same letter within the same column are not significantly difference at 5% level (P<0.05) according to the Tukey test

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