UNVEILING THE POTENTIAL NUTRIENTS PRESENT IN FRESH AND DRIED *MAKUEA POO-UNG*

Frances Betty Fraikue[1], Pillai Janardhanan. Prasanna Kumar[2], Edem Kwesi. Amenumey,[3] Samuel Joe Acquah[4]*

[1]Department of Hospitality Management, Takoradi Technical University, Takoradi, Ghana, Email:frances.fraikue@tpoly.edu.gh
[2]Ramaiah University of Applied Sciences
[3]Department of Tourism and Hospitality Management, University of Cape Coast.
[4]Department of Crop and Soil Sciences, Kwame Nkrumah University of Applied Sciences.

Abstract

Makuea poo-ung is a highly nutritious fruity vegetable. The main objective of this study was to compare the nutritional contents of fresh and dried makuea poo-ung, then compare to nutrients presents in general eggplants. Makuea poo-ung was pre-treated before reagents and chemicals were used to identify the specific nutrients present, whilst independent T-Test was used to analyse the significant differences. Results revealed that fresh and dried makuea poo-ung contained the six food nutrients. However, comparison between fresh makuea poo-ung and general nutrients in eggplants revealed very substantial diversions. Apart from Vitamin A which fell within the range of eggplants reviewed, most nutrients present in makuea poo-ung compared to eggplants were either less or more than the range reviewed. Conclusively, fresh and dried makuea poo-ung are nutritious to consume and serve as food supplements. It is recommended that commercial/traditional caterers and home makers should patronize makuea poo-ung.

Key words: Dried, Fresh, Food supplement, Makuea poo-ung, Nutrients.

INTRODUCTION

All eggplants belong to the scientific family solanaceae or nightshade, a scientific order called Polemoniaries (Bhaskar & Ramesh Kumar, 2015). Eggplant was initially named by an experimental Botanist, Thomas Jefferson, who also introduced it in the United States in 1706 (Jett, 2011). In the 18th century, some farmers from Europe upon seeing the colour of some eggplants resembling yellow and white eggs of hen and goose also gave it the name eggplant (Asiedu-Addo, 2014). Generally, knowledge of eggplant began in the 3rd century in India and in China, around the 4th and 5th century, then in Africa around the 9th century (Bhaskar & Ramesh Kumar, 2015, Sharma, Sharma & Rana, 2013). Eggplants were grown extensively by small-scale farmers as cash crops and domestically they grew on their own in gardens (Biology of Brinjal, 2015, Cassidy, Mukamal, Liu, Franz, Eliassen & Rimm, 2013, Dias, 2012). Still on their description, it was discovered that out of 98 accessions of eggplants, 58 belonged to Solanum melongena, 27 were Solanum aethiopicum and 16 were Solanum macrocarpon [Polignano et al, 2009, Sękara et al, 2007,]. Collectively, all these species of eggplant have marked similarities and dissimilarities with significant differences (Ali, Zhang, He, Bahadur, & Yi, 2011, Biology of Brinjal, 2015, Sękara et al, 2007,)

Eggplant is known as one of the ten sources of the world's healthiest food and counted among the best species cultivated worldwide (Bliss & Elstein, 2004, Caguiat & Hautea 2014). It has also gained the interest of scientist in a pharmacological sense as they belong to a group of compounds called alkaloids (McGehee, Krasowski, Fung, Wilson, Gronert, & Moss, 2000). Apart from the culinary and medicinal benefits, they are also used for decoration, fuel and for ritual purposes. These eggplants usually in season April to October (Bhaskar & Ramesh Kumar, 2015, Bliss & Elstein, 2004). According to Azevedo, Alves de Lima, Gomes, Stringheta,

Ribeiro, & Salvadori. (2007), Bhaskar & Ramesh Kumar,(2015), Biology of Brinjal,(2015), Cassidy et al.(2013), Dias,(2012), and Sharma et al.(2013), literature abounds in the generalized nutrients present in eggplants of 100 mg/g of all species. Table 1 exhibits a range of nutrients present in general eggplants.

Table 1: Main Nutrients Present in Fresh Eggplant per 100 mg/g

Food Nutrients	Nutrients in Fresh Eggplant
Energy	10.0 – 10.4g
Carbohydrates	4.70 - 5.88 g
Sugars	2.35 - 3.53 g
Dietary fiber	2.80 - 3.40 g
Fat	0.18 - 0.20 g
Protein	0.80 - 1.01 g
Retinol (A)	0.80 - 1.00 mg
Thiamine (B_1)	0.040 mg
Riboflavin (B_2)	0.04 - 0.11 mg
Niacin (B_3)	0.59 - 0.65 mg
Vitamin (B_6)	0.09 - 0.10 mg
Vitamin K	2.90 - 3.50 mg
Folate (B_9)	18 - 22 mg
Vitamin C	1.80 - 2.20 mg
Vitamin E	0.20 - 0.40 mg
Calcium	7.40 - 9.00 mg
Iron	0.20 - 0.24 mg
Magnesium	13.50 - 14 mg
Manganese	0.20 - 0.25 mg
Phosphorus	22.50 - 25 mg
Potassium	129 - 130 mg
Zinc	0.10 - 0.16 mg
Sodium	1.60 - 2.00 mg
Copper	0.10 - 0.12 mg

Source: Azevedo et al. (2007), Bhaskar & Ramesh Kumar, (2015), Biology of Brinjal, (2015), Cassidy et al. (2013), Dias, (2012), Sharma et al. (2013), USDA database. (2012)

Description of *Makuea Poo-Ung*

Makuea poo-ung is one of the eggplants which belongs to the solanum *melongena group*. It is described as a miniature eggplant (Prosperosa) which appears as small, round and pea/cherry tomato-like in shape that belongs to one group of Thai eggplants. The fruit has thin and light green skin, bitter taste (due to its saponin content), has a smooth texture and hard flesh (Choudhury, 1976, Peralta et al, 2005). An Eggplant has a diameter of about 0.4 inch or 1 cm. They grow in clusters much like cherry tomatoes, hanging from the vine of a plant and in groups of 10 to 15 per cluster with thorns on the stem (Bliss and Elstein, 2004,

Whitaker and Stommel, 2003) is very nutritious and has been described as an iron chelator because it is rich in iron and other minerals, vitamins as well as being fibrous (Ashworth, 2000, Bhaskar & Ramesh Kumar, 2015, Cassidy et al, 2013, Krisban, 2013, Putra, 2011). In Ghana, the eggplant is referred to as *nsaman ntroba by the Fantis, khawu nsusua by the Akuapims, Kantosi by the (Gas), Yaa Asantsewaa/Amagyiree by the Ashantis, etenvi by the* (Ewes) and ageeboa by the Northerners (Krisban, 2013, Putra, 2011). There are other species of the Cherry eggplant *(Makuea poo-ung)* notably Turkey berry *(Solanum torvum),* Thai eggplants (*Makuea Praow*) and Pea eggplants (*Makua Puong*), their differences are visibly seen on the colour, size, plant leaves and botanical name.

When drying *makuea poo-ung,* they undergo numerous processes in order to expend moisture content. Studies have shown that after drying, eggplants in general encounter different status of nutrients and the moisture content left after processing is less than 10% (Biology of Brinjal, 2015, Muyandar & Devahastin, 2014, Santacatalina, Ozuna, Cárcel, García-Pérez, & Mulet, 2011). Other authors have affirmed that there could be either nutrient gain or loss after processing eggplant into powder (Çağlarırmak and Hepçimen, 2013, Nyadanu, Aboagye, Akromah, Osei, & Dordoe, 2011, Putra, 2011, Skip The Pie link, 2015, USDA database, 2012)., it has also been proven by Fraikue, Prasanna Kumar and Amenumey (2017) that, dried *makuea poo-ung* can be stored at room temperature in glass containers up to 4 months at most after production, It can be stored in the fridge for up to one year after production. This means that during the lean season dried *makuea poo-ung* could still be used. More so, drying *makuea poo-ung* for use during the lean season does not compromise the nutritional value but rather makes it a handy condiment for usage by homemakers.

One main challenge is that, the specific nutrients in both fresh and dried *makuea poo-ung* alone remain unknown, although nutrients present in all eggplants are available (Azevedo et al, 2007, Bhaskar & Ramesh Kumar, 2015, Biology of Brinjal, 2015, Cassidy et al, 2013, Dias, 2012, Sharma et al, 2013, USDA database, 2012). Most consumers barely eat *makuea poo-ung* due to the fact that they are not privy to the nutritional benefits present in it. Few patrons of *makuea poo-ung* interviewed by the researchers indicated that, they use it for soups and sauces because they have heard it contains several nutrients. In order to sensitize more consumers to patronize *makuea poo-ung,* the researcher aimed to unearth the specific nutrients present in fresh and dried makuea poo-ung. The main objective of this study was to analyse the specific nutrients present in fresh and dried *makuea poo-ung,* as well as fresh *makuea poo-ung* and general eggplants. The study also seeks to compare the nutritional differences between fresh and dried makuea poo-ung. It is also hypothesized that:

H_1: There is a significant difference between nutrients present in fresh and dried *makuea poo-ung*

RESEARCH APPROACH

Makuea poo-ung was harvested around 6.00am from a farm. They were washed and pre-treated at the Soil Science Laboratory at Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. A 100g/mg of fresh makuea poo-ung was measured and pre-treated for the analysis of specific nutrients present. Likewise, an amount of fresh *makuea poo-ung* was dried in an oven for 10 hours at a temperature of 80ºC for 6 hours and 70ºC for 4 hours. Dried makuea poo-ung was then milled into powder and 100g/mg was weighed. The pre-treated fresh and powdered makuea poo-ung were put into bottles and the nutrients were analysed. The nutrients present were compared using a table. Paired sample T. Test was also used to test the hypothesis to find out if there was any significant difference in the two states of *makuea poo-ung.* The principle underlying this comparison was to assess the relevant importance in the consumption of fresh and dried *makuea poo-ung.* This assessment of nutritional contents present in both fresh and dried *makuea poo-ung* were undertaken at the Soil Science Laboratory (for minerals and others) and the Advanced Testing

Laboratory (for vitamins) at Ramaiah University of Applied Sciences (RUAS), Bangalore, India.

Assessment of Nutrients Present in Fresh and Dried *Makuea Poo-Ung*

The experiment undertaken to assess the specific nutrients present in fresh *makuea poo-ung* made use of various reagents, chemicals and equipment. In all nine minerals comprising five vitamins, protein, carbohydrate, fibre, ash and fat were assessed so as to unveil the specific quantities of nutrients.

Preparation and wet digestion of fresh *Makuea poo-ung* for elemental analysis

One (1.0 g) of the sample was weighed into a clean 500 ml digestion flask and 20 ml of aqua regia (1 part of HNO3 + 3 parts of HCl) was added. The digestion flask with the mixture was heated in the DK20 heating digester block starting at a temperature of 80oC and then the temperature was raised to 150oC. The content of the digestion flask was heated until the volume was reduced to about 5 ml. The content of the digestion flasks were cooled and the volume made up to 100 ml in volumetric flasks. The volumetric flasks were labelled accordingly. An empty flask was included for a blank. The clear supernatant digest were decanted into clean reagent bottles for K, Ca, Mg, Na, P, Cu, Fe, Mn and Zn determinations.

Determination of copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn)

The basic setup (air pressure = 50 – 60 psi, acetylene pressure = 10 -15 psi and voltage = 208 – 240V) of the AAS was ensured. The file for the type of analysis and hollow cathode lamps were selected with appropriate wavelengths - Fe at 248.3 nm, Cu at 324.8 nm, Zn at 213.9 nm and Manganese at 279.5 nm. A calibration curve was plotted for each of the elements to be analyzed from the stock standards (Buck Scientific). The prepared sample solution digest were analyzed for the elements. The Y in the calibration equation is absorbance of the element and X is the concentration of the element in the sample. X was calculated after substituting the absorbance reading of the sample into the calibration equation. This gave X in terms of mg/L. The total concentration of the element in the sample solution (100 ml) was calculated by multiplying the concentration in mg/L by 0.1L. This gave the total mass of the element in solution. The percentage amount of the element was found by dividing the mass of the element in solution by initial amount of sample taken followed by a multiplication by 100.

Conc. (Cu, Fe, Mn, Zn) (mg/kg) = Concentration recorded from AAS X Nominal volume

Sample weight (g) Where, Nominal volume = 100 ml so Sample weight = 1.00g

Determination of phosphorus (P)

A vanadomolybdate reagent was prepared by dissolving 22.5 g of ammonium molybdate in 400 ml of distilled water and 1.25 g of ammonium vanadate in 300 ml of boiling distilled water. The vanadate solution was added to the molybdate solution and cooled at room temperature. These were measured on the Spectronic 20 spectrophotometer to give absorbance measurements.

Determination of potassium (K) and sodium (Na)

KCl and NaCl respectively were previously dried in an oven for 4 hours at 105oC and dissolved in 200 ml of deionized water. The two were mixed to a volume up to 1000 ml. All the absorbance reading were taken using the flame photometer for K and Na content (µg) in 1.0 g of plant sample.

Determination of calcium (Ca)

A 5.0 ml of sample solution from 3.4.2.2 was transferred into a 100 ml Erlenmeyer flask. 10 ml of 10 % KOH solution was added followed by 1 ml of 30% TEA. Three drops of 10 % KCN and few drops of EBT indicator solution. The mixture was shaken to ensure homogeneity. The mixture was titrated with 0.02 N EDTA solution from a red to blue end point.

Calcium in mg = Titre value of EDTA x 0.4008

$$\% \text{ Calcium} = \frac{\text{mg Calcium}}{\text{Sample wt x volume}} \times 100$$

Determination of magnesium (mg)

In the determination of magnesium, 5.0 ml sample solution from 3.4.2.2 was emptied into a 100 ml Erlenmeyer flask. 5 ml of ammonium

chloride – ammonium hydroxide buffer solution was added followed by 1 ml 30% TEA. Three drops of 10 % KCN and a few drops of EBT indicator solution. The mixture was shaken to ensure homogeneity. The mixture was titrated with 0.02 N EDTA solutions from a red to blue endpoint.

Magnesium in mg = Titre value of EDTA x 0.243

% Mg = mg Magnesium x 100
Sample wt x Volume

Determination of ash and fat

Ash is the inorganic residue obtained by burning a sample at 600oC. Ashing of a feed sample burns off all organic constituents, leaving behind the non-volatile mineral elements. The temperature used for this determination may also affect some elements such as selenium and arsenic, which form volatile oxides when present. These losses can therefore be avoided by addition of known quantities of calcium oxide prior to ashing.

Apparatus: i. Muffle furnace

ii. Porcelain crucibles

iii. Desiccator with magnesium perchlorate desiccant.

Procedure: i. Remove ash crucible from oven, place in desiccator, cool and weigh.

ii. Weigh about 2.0000 g (record exact mass) of sample into porcelain crucible in duplicate.

iii. Put into furnace for 4 hours at 550oC.

iv. Allow furnace to cool below 200oC and maintain this for 20 minutes.

v. Place crucible in desiccator with stopper top, cool and then re-weigh

Calculation: (A + B) – A = B, (A + C) – A = C

% Ash = C/B × 100 where A = crucible weight, B = sample weight, C = ash weight.

Ether extract (fat) is a fatty acid ester of glycerol. The term lipid is used for all ether-soluble materials. Fats are those glycerol esters, which are solid, while oils are liquids at ordinary temperatures. Seeds like groundnut, soyabean and cotton contain oil as reserved food material.

Ether extract is determined by extracting the dry sample with ether. The weight of the extract is determined after distilling the ether and weighing the residue. The ether extraction may be conducted with a suitable apparatus such as Soxhlet.

Apparatus: Whatman No.2 filter paper, Absorbent cotton wooland Soxhlet apparatus,

Reagent: Petroleum ether

Procedure: i. Fold a piece of filter paper in such a way that it would be able to hold the sample. Wrap around a 2nd filter, which is left open at the top like a thimble. A piece of cotton wool is placed at the top to evenly distribute the solvent as it drops on the sample during extraction.

ii. Place the sample packet in the butt tubes of the Soxhlet extraction apparatus.

iii. Extract with petroleum ether for 2 hours without interruption by gentle heating.

iv. Allow it to cool and dismantle the extraction flask. Evaporate the ether on a steam or water bath until no odour of ether remains.

v. Cool at room temperature for overnight

vi. Carefully remove the dirt or moisture outside the flask and re-weigh the flask

CALCULATIONS: (A + B) – A= B % ether extract = B/C x 100

Where A = flask weight, B = ether extract weight, C = sample weight

Determination of fiber and protein

The carbohydrate of food is contained in 2 fractions: (1) the crude fibre and (2) the nitrogen – free extractives. Crude fibre refers to the organic residue of a feed that is insoluble after successive boiling with 0.255 N H2SO4 and 0.312 N NaOH solutions according to specified procedures. The determination of crude fibre is an attempt to separate the more readily digestible carbohydrates from those less readily digestible. The crude fibre fraction contains cellulose, lignin and hemicellulose. Boiling a sample with dilute acid and alkali is an attempt to imitate the process that occurs in the digestive tract. This procedure is based on the supposition that carbohydrates, which are readily dissolved by this procedure, will also be readily digested by animals, and that those not soluble under these conditions are not readily digested. At best, this is only a rough approximation of the indigestible material in feedstuffs, but quite a large part of it may in fact be digested by ruminant animal. Nevertheless, crude

fibre is used as a rough indicator in estimating the energy value of feeds. It is also valuable because of the correlation existing between it and the digestibility of the feedstuff.

Apparatus: Condenser, Digestion flask - a 500 ml Erlenmeyer flask is recommended, Filtering cloth of such character that no appreciable solid matter passes through when filtration is rapid, Air- tight sample containers, an electric furnace and a Gooch crucible

Reagents: Sulphuric acid solution: 0.255 N: 1.25g H2SO4/100 ml distilled water, Sodium hydroxide solution: 0.312 N: 1.25g NaOH/100ml distilled water, Anti- foaming agent: N-tributyl citrate and 95% ethanol.

Procedure: i. Transfer weighed residue from the ether extract to a digestion flask.

ii. Add 200ml of the boiling H2SO4 solution, add anti-foaming agent. Immediately connect digestion flask with condenser and heat.

iii. After 30 minutes, remove flask, filter immediately through linen and wash with boiling water until washings are no longer acid.

iv. Heat a quantity of NaOH solution to boiling point and keep at this temperature under reflux condenser until used.

v. Wash residue back into flask with 200 ml of the boiling NaOH solution. Connect flask with reflux condenser and boil for exactly 30 minutes.

vi. After 30 minutes, remove flask and immediately filter through the Gooch crucible.

vii. After thorough washing with boiling H2O, wash with 15 ml of 95% ethanol. Dry crucible and contents at 110oC to constant weight. Cool in a desiccator and weigh.

viii. Incinerate contents of crucible in muffle furnace at 550oC for 30 minutes until the carbonaceous matter has been consumed. Cool in a desiccator and weigh. Record loss in weight as crude fibre.

Calculation: % crude fibre = A – B x 100 & C

A = wt. of dry crucible and sample B = wt. of incinerated crucible and ash, C = sample weight

The crude protein content is calculated from N content of the food, determined by a modification of a technique originally devised by Kjeldahl. The micro Kjeldahl technique is adopted to estimate the total N content in a variety of samples ranging from microbial cells to meat. With this method, the N in protein or any other organic material is converted to ammonium sulphate by H2SO4 digestion. This salt, on steam- distillation, liberates NH3 which is collected in boric acid solution and titrated against standard acid. Since 1 ml of 0.1 N acid is equivalent to 1.401mg N, calculation is made to arrive at the N content of the sample. It is assumed that the N is derived from protein containing 16% N, and multiplying the N figure by 100/16 or 6.25, an approximate protein value is obtained.

Apparatus i. Kjeldahl flasks: 30 ml hard glass flask

ii. Digestion rack: commercial heating apparatus

iii. Distillation apparatus

Reagents i. Sulphuric acid (specific gravity 1.84)

ii. Sodium sulphate

iii. Copper sulphate

iv. Sodium hydroxide- Sodium thiosulphate solution: - Dissolve 600 g NaOH and 50 g Na2S2O3. 5 H2O in distilled water and make up to 1 litre.

v. Indicator solution: methyl red 0.2 g / 100 ml ethanol, methylene blue 0.2 g /100 ml ethanol. For the mixed indicator, two parts of methyl red solution are added to 1 part of methylene blue solution.

vi. 4% Boric acid solution.

vii. Standard HCl, 0.1 N

viii. Boiling chips and or glass beads

Procedure i. Weigh 2.0 g of the sample and transfer to a 30 ml digestion flask

ii. Add one spatula full of Kjeldahl catalyst (sodium sulphate + copper sulphate + selenium powder mixture) and 20 ml concentrated H2SO4 to the digestion flask.

iii. Add boiling chips and digest the sample till the solution becomes colourless.

iv. After cooling the digest, dilute it with a small quantity of distilled ammonia- free water and transfer to the distillation apparatus. The Kjeldahl flask should be rinsed with successive small quantities of water.

v. Place a 100 ml conical flask containing 5 ml of boric acid solution with a few drops of mixed indicator with the tip of the condenser dipping

below the surface of the solution.
vi. Add 10 ml sodium hydroxide–sodium thiosulphate solution to the test solution in the apparatus.
vii. Distil and collect the ammonia on boric acid. At least 50 ml of distillate should be collected.
viii. Rinse the tip of the condenser and titrate the solution against the standard acid until the first appearance of violet colour, i.e. the end point.
ix. Run a reagent blank with equal volume of distilled water and subtract the titration volume from that of sample titration volume.
Calculation: The N content of the sample can be calculated by the formula: N (g kg -1) = (ml HCl – ml blank) x Normality x 14.01÷ Weight of sample (g) x 10, % Crude Protein = % Total N x 6.25

Determination of fat-soluble vitamin analysis

These were vitamin A (Retinol), D (Calciferol), E (Tocopherol), K (phytonadione). Reagents and chemicals used were Methanol, Acetonitrile, HPCL grade water and Gradient flow with 0.35ml/min. Potassium Hydroxide (KOH), Hydroquinone, Petroleum ether, sodium chloride (NaCl), Phenolphthalein indicator, two molecules of sodium together with four molecules of sulphur oxide (Na2SO4) and anhydrous were also used for the analysis of nutrients (100mg/ml). Although researchers such as Azevedo, Alves de Lima, Gomes, Stringheta, Ribeiro, & Salvadori, (2007), Bhaskar & Ramesh Kumar, (2015), Biology of Brinjal, (2015), Cassidy et al, (2013), Dias, (2012), Sharma et al, (2013), found out that vitamin D was absent in all eggplants, the nutritional content was still assessed in order to confirm or refute the existing literature.

Determination of water-soluble vitamin analysis

Analysis for vitamin B1 (Thiamine), B2 (Riboflavin), B3 (Niacin), C (Ascorbic acid) made use of Methanol and High Performance Liquid Chromatography machine. They were used to separate, identify, and quantify each nutrient component in a mixture with grade water and Trifluoroacetic acid (TFf A). Again, in the UPLC, 0.05% TFA were combined with methanol were blended to attain standards. Thiamine Hydrochloric acid (HCl), Nicotinamide and ascorbic acid stocks were prepared in water using the LC-MS to analyse nutrients present.

RESULTS AND DISCUSSIONS

Fresh and dried *makuea poo-ung* contained all the six food nutrients. These were protein, carbohydrate, fat, fibre, ash, moisture, minerals and vitamins. The mineral elements present were calcium, magnesium, potassium, sodium, phosphorus, coppers, iron, manganese and zinc. Vitamins present were Vitamin A, B1, B2, B3 and C. Generally, all 98 species of eggplant do not contain vitamin D, but have vitamin E and K present (Ashworth, 2000; Azevedo et al.2007; Bhaskar & Ramesh Kumar, 2015, Biology of Brinjal, 2015, Cassidy et al, 2013, Dias, 2012, Sharma et al., 2013; USDA database, 2012). As results from nutrients present in makuea poo-ung was compared to existing literature, the study revealed that it had no vitamin D, E and K. Furthermore, specific nutrients present in fresh and dried makuea poo-ung was assessed using paired sample T.Test

Results on Nutrients Present in Fresh and Dried Makuea Poo-ung

This session compared the nutrients present in both fresh and dried makuea poo-ung. Generally there were differences between them. Nutrients like calcium, magnesium, sodium, fat, vitamin B1and vitamin C attracted the smallest difference of less than 0.10mg/g while vitamin A and B2, nutrients in the fresh makuea poo-ung was slightly higher with an amount less than 1.0mg/g than that of dried makuea poo-ung. Furthermore, copper, carbohydrate and moisture content reduced massively when makuea poo-ung was dried with a difference of 6.64mg, 13.74g and 72.78 ml respectively.

Table 2, shows that some nutrients increased in the dried makuea poo-ung. Among these were potassium, phosphorus, manganese, zinc, fibre and vitamin B3. Additionally, the nutritional content of protein present in fresh makuea poo-ung (2.07g) was far less than what was present in dried makuea poo-ung (13.86g). This amounted to a nutritional difference of

11.79g. Ultimately, iron content in fresh makuea poo-ung which was as little as 1.21 mg, increased to 12.90mg when makuea poo-ung was dried.

Table 2: Nutrients Present in 100mg/g of Fresh and Dried Makuea poo-ung

Type of Nutrient	Fresh *makuea poo-ung*	Dried *makuea poo-ung*
Calcium	1.03	1.04
Magnesium	0.64	0.62
Potassium	2.99	3.23
Sodium	0.15	0.12
Phosphorus	0.38	0.82
Copper	12.19	5.55
Iron	1.21	12.90
Manganese	0.38	0.98
Zinc	0.47	0.78
Fat	0.74	0.79
Fibre	8.67	9.69
Ash	4.48	1.34
Moisture	81.71	8.93
Protein	2.07	13.86
Carbohydrate	75.38	64.64
Vitamin A	0.96	0.11
Vitamin B_1	0.09	0.06
Vitamin B_2	0.56	0.46
Vitamin B_3	0.17	0.30
Vitamin C	0.10	0.11
Vitamin D	None	None

Further Analysis on Nutrients Present in Fresh and dried Makuea Poo-ung

Independent T-Test was used for further analyses. The analysis carried out to ascertain whether there were potential significant differences between fresh and dried *makuea poo-ung.*

Table 3: Paired Sample T-Test between Fresh and Dried *Makuea Poo-Ung*

Paired Differences								
Samples	Mean difference	Standard deviation	Std. error mean	95% confidence interval of the difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Fresh and Dried *makuea poo-ung*	0.35174	18.62902	3.88442	-7.70405	8.40753	.091	22	0.929

Source: Fieldwork, 2017

From the test, it was realized that the mean amounts of nutrients present in fresh *makuea poo-ung* was 8.4509 whiles that of dried *makuea poo-ung* was 8.0991. The difference between the means of fresh and dried *makuea poo-ung* was 0.35174, indicating clearly that the mean difference was negligible. More so, the standard deviation between fresh and dried *makuea poo-ung* was about 1.1 difference in their errors. Additionally, the mean value of 0.35174 and the error mean of 3.88442 also showed only a small difference between fresh and dried *makuea poo-ung.*

At '95% confidence interval', the differences in the amounts of nutrients present in the types of nutrients among the fresh and dried *makuea poo-ung* fell between -7.70405 to 8.40753, this also affected a very small test value of 22 as the 'degree of freedom'. The significant value was 0.929 indicating that the differences between the fresh and dried *makuea poo-ung* was statistically insignificant. The result implies that the alternative hypothesis which states that there is a significant relation between nutrients present in fresh and dried *makuea poo-ung* was rejected. The outcome is that, both fresh and dried *makuea poo-ung* are equally nutritious and therefore can be consumed domestically and at all food service establishments as food supplement.

Results on Nutrients Present in Fresh *Makuea Poo-ung* as against general Eggplants

The fresh *makuea poo-ung* assessed contained 20 different nutrients whilst eggplant in general have 24 nutrients. From Table 4, the moisture content of fresh eggplants was not calculated in previous studies (Azevedo et al., 2007; Bhaskar & Ramesh Kumar, 2015; Biology of Brinjal,2015; Cassidy et al.; 2013; Dias, 2012; Sharma et al 2013; USDA database, 2012). This was very relevant because the moisture content in the different species of eggplants varied greatly and so calculating a range was not possible. Likewise, ash in fresh *makuea poo-ung* was not present in the nutrients present in general eggplants.

The comparative study (Table 4) further revealed that *makuea poo-ung* had no energy, sugars, Vitamin B6, B9, K and E as compared to general nutrients present. Furthermore, Vitamin A nutrient present in *makuea poo-ung* fell within the range of general nutrients reviewed. More so, some nutrients present in *makuea poo-ung* were totally outside the range reviewed (manganese, copper, zinc, iron, Vitamin B1, B2, protein, carbohydrate, fat and fibre). Again, some other nutrients in *makuea poo-ung* were far less than the range reviewed (calcium, magnesium, potassium, phosphorus, sodium, Vitamin B3 and C). This confirmed that specific nutrients present in only *makuea poo-ung* had not been reviewed by researchers as stated in the problem statement.

CONCLUSIONS AND RECOMMENDATIONS

Eggplants in general contains all six food nutrients with the exception of vitamin D. In the assessment of specific nutrients present in makuea poo-ung, results the study showed that all nutrients were present with the exception of vitamin D, E and K. Although nutrients present in generalized eggplant were almost the same as that of makuea poo-ung, the amount of nutrients present were different. Apart from Vitamin A which fell within the range of eggplants reviewed, most nutrients present in makuea poo-ung compared to eggplants were either less or more than the range reviewed. The assessment of nutrients present in fresh and dried makuea poo-ung equally attained some slight differences and similarities. Further analysis using Independent T-Test revealed that there were no significant differences between the nutrients present in fresh and dried makuea poo-ung. Furthermore, their significant values were higher than the probability value of 0.05, the alternative hypothesis was rejected. Conclusively, both fresh and dried makuea poo-ung could be purchased and consumed since their nutritionaldifferences are insignificant. It is recommended that both fresh and dried makuea poo-ung should be added to all foods prepared in commercial catering establishment such as hotels, restaurants, ands traditional catering establishments. Makuea poo-ung is seasonal and nutritious, therefore it is highly recommended that caterers should use it as a food supplement due to its nutritional value.

Table 4: General Nutrients Present in Fresh Eggplant per 100mg/g as against Fresh *Makuea Poo-ung*

Food nutrients	General nutrients present in fresh eggplant	Nutrients in fresh makuea poo-ung
Energy	10.0 – 10.4g	-----
Carbohydrates	4.70 - 5.88 g	75.38 g
Sugars	2.35 - 3.53 g	-----
Dietary fiber	2.80 - 3.40 g	8.67 g
Fat	0.18 - 0.20 g	0.74 g
Protein	0.80 - 1.01 g	2.07 g
Retinol (A)	0.80 - 1.00 mg	0.96 mg
Thiamine (B_1)	0.040 mg	0.09 mg
Riboflavin (B_2)	0.04 - 0.11 mg	0.56 mg
Niacin (B_3)	0.59 - 0.65 mg	0.17 mg
Vitamin (B_6)	0.09 - 0.10 mg	-----
Vitamin K	2.90 - 3.50 mg	-----
Folate (B_9)	18 - 22 mg	-----
Vitamin C	1.80 - 2.20 mg	0.10 mg
Vitamin E	0.20 - 0.40 mg	-----
Calcium	7.40 - 9.00 mg	1.03 mg
Iron	0.20 - 0.24 mg	1.21 mg
Magnesium	13.50 - 14 mg	0.64 mg
Manganese	0.20 - 0.25 mg	0.38 mg
Phosphorus	22.50 - 25 mg	0.38 mg
Potassium	129 - 130 mg	2.99 mg
Zinc	0.10 - 0.16 mg	0.47 mg
Sodium	1.60 - 2.00 mg	0.15
Copper	0.10 - 0.12 mg	12.19

Source: Fieldwork, 2017

ACKNOWLEDGEMENTS

Appreciation goes to the laboratory technicians at the Soil Science Laboratory at Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana and Advanced Testing Laboratory at Ramaiah University of Applied Sciences (RUAS), Bangalore, India.

REFERENCES

Ali, Z., Xu, Z. L., Zhang, D. Y., He, X. L., Bahadur, S. & Yi, J. X (2011) Diversity analysis of eggplant (Solanum melongena) genetic resources, Genetic Molecular Research, online Journal Genetic Molecular Research, 10 (2), 1141-1155.

Ashworth, S. (2000). Growing eggplants successfully, *Tauton's Kitchen Gardener*, 24-28.

Asiedu–Addo, S. (2014). Turkey berry: The wonderful medicinal plant. Daily Graphic Online. Thursday, 16th January, Retrieved on 29th July, 2015, from graphic.com. gh/…/15850-turkey-berry-the-wonderful-medicine-plant.html.

Azevedo, L., Alves de Lima, P. L., Gomes, J. C., Stringheta, P. C., Ribeiro, D. A. & Salvadori, D. M. (2007). Differential response related to genotoxicity between eggplants (Solanum Melanogena) skin aqueous extract and its main purified anthocyanin (delphinidin) in vivo, *Food Chemistry Toxicology*, *45*(5), 852-858.

Bhaskar, B., & Ramesh Kumar, P. (2015). Genetically modified (GM) crop face an uncertain future in India: Bt Brinjal Appraisal – A perspective, *Annals of Plant Sciences 4*(2), 960- 975.

Biology of Brinjal (2015). General description of Brinjal or eggplant (Solanum melongena L.) Government of India Department of biotechnology, Ministry of science and technology. Retrieved from dbtbiosafety. nic.in/guidelines/brinjal on 4th October,

2015

Bliss, R. M., & Elstein, D. (2004). *Scientists get under eggplants skin. ARS magazine,* January 2004; 52 (1) http://wwwars.usda.gov/is/AR/archive/jan04/skin0104.htm. Retrieved 28th July, 2015.

Caguiat, X. G. I. & Hautea D. M. (2014). Genetic diversity analysis of eggplant (Solanum melongena L.) and related wild species in the Philippines using morphological and SSR markers, *SABRAO Journal of Breeding and Genetics, 46*(2), 183-201.

Çağlarırmak, N. & Hepçimen, A. Z., (2013) An investigation of nutritional values of dried vegetables, Gida, 38 (6), 327-333.

Cassidy, A., Mukamal, K. J., Liu, L., Franz, M., Eliassen, A. H. & Rimm, E. B. (2013). High anthocyanin intake is associated with a reduced risk of myocardial infarction in young and middle-aged women, *Circulation*, *127*(2), 188-196.

Choudhury, B. (1976) Vegetables. (4th Revised Edition), India, New Delhi, National Book Trust.

Dias, J. S. (2012). Nutritional quality and health benefits of vegetables: A review, *Food and Nutrition Sciences, 3*(1), 1354-1374.

Fraikue, F. B., Prasanna Kumar, J. P & Amenumey, E. K (2017). Production of dried makuea poo-ung as a convenient food for family usage. First Bi-annual TTU Research Conference; Paper Presented at the University Auditorium from 22nd – 23rd November, 2017.

Jett, L. W. (2011). *Division of plant sciences,* University of Missouri extension, ADA Institution.

Krisban, S. (2013). *8 excellent reasons to eat more eggplant. Care 2 healthy living*. Retrieved from www.care2.com/greenliving/8-great-reasons-to-eat-eggplant-html on 16th July, 2015.

McGehee, D. S., Krasowski, M. D., Fung, D. L., Wilson, B., Gronert, G. A. & Moss, J. (2000). Cholinesterase inhibition by potato glycoalkaloids slows mivacurium metabolism, *Anesthesiology*, 93(2), 510-519.

Muyandar, A. S., Devahastin, S., (2014). Fundamental principles of drying, Handbook of industrial drying, Chapter 1, 4th edition; London, CRC Press; pp. 1-22.

Nyadanu, D., Aboagye, L. M., Akromah, M. K. Osei, M. K. & Dordoe, M. B. (2014). Agromorphological characterization of gboma eggplant, an indigenous fruit and leafy vegetable in Ghana, *African Crop Science Journal*, *22*(4), 281-289.

Peralta, I. E., Knapp, S. K. & Spooner, D. M. (2005). New species of wild tomatoes (Solanum

Lycopersicon: Solanaceae) from Northern Peru, *System Botanical, 30*(0), 424 - 434.

Polignano, G., Uggenti, P., Bisignano, V., Della, C. & Genent, G. (2010) 'Gnenetic divergence analysis in eggplant (Solanum melongena L.) and allied species', Resource Crop Evolution, 57(1), 171–181.

Putra, G. (2011). *Nutrition is a key to health*. Retrieved from www.nutrient.net on 28th February 2014.

Santacatalina, J. V., Ozuna, C., Cárcel, J. A., García-Pérez, J.V., & Mulet, A. (2011). Quality assessment of dried eggplant using different drying methods: hot air drying, vacuum freeze dryingand atmospheric freeze drying. *International Congress on Engineering and Food Conference*, *1*(1), 1-6.

Sękara, A., Cebula, S. & Kunicki, E. (2007) Cultivated eggplants – origin, breeding objectives and genetic resources, A Review', Folia Horticulture Ann, 19(1), 97-114.

Sharma, D. K., Sharma, N. & Rana, S. (2013). Seed-borne diseases of brinjal (Solanu Melongena L.) and their control measures: A review, Review *Article International Journal of Bioassays, 2*(11), 1428-1433.

Skip The Pie link. (2015) USDA Record"11210" *Nutritional Comparison: Kale, raw vs Eggplant, cooked, boiled*. Retrieved from skipthepie.org on 13th October, 2015.

USDA database (2012). *USDA National Nutrient Database for Standard Reference Release 27*, 28(10), 1028-1035.

Whitaker, B. D. & Stommel, J. R. (2003). Distribution of Hydroxycinnamic acid conjugates in fruit of commercial eggplant (Solanum melongena L.) cultivars, *Journal of Agricultural Food Chemistry, 51*(11), 3448-3454.