

COMPARATIVE NUTRITIONAL AND PHYTOCHEMICAL ANALYSES OF TWO VARIETIES OF *Solanum melongena*.

*AGOREYO, B. O.; OBANSA, E. S. & OBANOR, E. O.

Department of Biochemistry, Faculty of Life Sciences, University of Benin, P.M.B. 1154, Benin City, Nigeria.

*agoreyobo@yahoo.com

ABSTRACT

Comparative nutritional and phytochemical analyses of the unripe fruits of round and oval shape varieties of *Solanum melongena* showed high moisture content of $78.44 \pm 0.49\%$ and $72.93 \pm 0.76\%$ respectively. Lower carbohydrate and lipid contents of $11.77 \pm 1.55\%$ and $1.65 \pm 0.62\%$ respectively were found in the round variety than the oval variety. The levels of protein, fibre, calcium, iron and potassium were higher in the round variety than the oval variety. Higher level of magnesium, phosphorus and sodium was found in the oval variety than the round variety but the level of zinc was the same in both varieties ($0.25 \pm 0.001\%$). The quantitative phytochemical analysis revealed that phytate and oxalate, although not high but were higher in the round variety than in the oval variety. Similarly, alkaloid, and tannin were higher in the round variety, while saponin was higher in the oval variety. These results suggest that these fruits especially the round variety, possess nutritional and health benefits for diabetic patients, individuals that are watching their weight and those with ischemic heart diseases.

Key words: Nutritional, Phytochemical, *Solanum melongena*, Eggplants, round variety, oval variety

INTRODUCTION

Solanum species (eggplants) belong to the family of *Solanaceae* and the plant genus *Solanum* with over 1,000 species worldwide. It is represented in Nigeria by about 25 species including those domesticated; with their leaves, fruits or both eaten as vegetables or used in traditional medicine (Bonsu *et al.*, 2008; Manoko & van der Weerden, 2004). They are known as garden eggs in Nigeria and called gauta in hausa, afufa or anara in igbo or igba in yoruba. They are highly valued constituents of the Nigerian foods and indigenous medicines that are either eaten raw or cooked, very popular in mixed and rich dishes such as stews and soups (Edem *et al.*, 2009), especially in the southern and western parts of Nigeria, although, they are highly cultivated in the north. (Chinedu *et al.*, 2011). Eggplants come in different species and varieties. They also vary in fruit color, shape, and size (Akanitapichat *et al.*, 2010; Chinedu *et al.*, 2011). *Solanum melongena* is small and white in colour, having two varieties that are round or oval in shape; yellow and red in colour, when they are ripe and overripe respectively. They are either eaten raw as dessert or cooked and used for the preparation of stews, soups and sauces eaten with yam or plantain.

Eggplants have indigenous medicinal uses, which range from weight reduction to treatment of several ailments including asthma, skin infections and constipation. Various plant parts are used in decoction for curing ailments such as diabetes, leprosy, gonorrhoea, cholera, bronchitis, dysuria, dysentery, asthenia and haemorrhoids. (Gill, 1992; Bello *et al.*, 2005). Nutritional and phytochemical information on some Nigerian *Solanum* species are scanty and it is difficult to assess the values of these species in this regard.

MATERIALS AND METHODS

Plant material: Unripe fruits of the various *S. melongena* (eggplants) varieties were purchased from a local Market in Benin

City, identified and authenticated at the Department of Pharmacognosy, Faculty of Pharmacy, University of Benin, Benin City. The fruits were diced and a portion of the fresh samples was taken from each variety and used for moisture content determination, while the rest samples were dried, pulverized and used for the determination of crude protein, lipid, fibre, ash content, carbohydrate, mineral content and for phytochemical analysis.

Moisture content determination: Two grammes of the fresh sample of each *S. melongena* variety was placed in the crucible and heated at 105°C until a constant weight was attained. The moisture content of each variety was calculated as loss in weight of the original sample and expressed as percentage moisture content (FAO, 1980).

Determination of crude protein: The crude protein was determined by the Kjeldahl method with slight modification. 0.5 g of the powdery form of each *S. melongena* variety was digested with 5 ml of concentrated sulphuric acid in the presence of Kjeldahl catalyst. The nitrogen from the protein in the sample was converted to ammonium sulphate that reacted with 2.5 ml of 2.5% Brucine reagent, 5 ml of 98% sulphuric acid to give a coloured derivative and the absorbance read at 470 nm. The percentage nitrogen was calculated and multiplied by 6.25 to obtain the value of the crude protein (A.O.A.C., 1990).

Estimation of crude lipid: This estimation was performed using the Soxhlet extraction method. Ten grammes of the powdery form of each *S. melongena* variety were weighed and wrapped with a filter paper and placed in a thimble. The thimble was covered with cotton wool and placed in the extraction column that was connected to a condenser. 200 ml of n-Hexane was used to extract the lipid (A.O.A.C., 1990).

Determination of crude fibre: The estimation was done using the method of A.O.A.C. (1990). Five grammes of the powdery form of each *S. melongena* variety and 200 ml of 1.25% H_2SO_4 were heated for 30 min and filtered with a Buchner funnel. The residue was washed with distilled water until it was acid free. 200 ml of 1.25% NaOH was used to boil the residue 30 min, it was filtered and washed several times with distilled water until it was alkaline free. It was then rinsed once with 10% HCl and twice with ethanol. Finally it was rinsed with petroleum ether three times. The residue was put in a crucible and dried at 105°C in an oven overnight. After cooling in a desiccator, it was ignited in a muffle furnace at 550°C for 90 minutes to obtain the weight of the ash.

Determination of ash content: This was done using the method of A.O.A.C (1990). The total ash content of a substance is the percentage of inorganic residue remaining after the organic matter has been ignited. 2 g of the pulverized *Solanum* samples was placed in a crucible and ignited in a muffle furnace at 550°C for 6 hours. It was then cooled in a desiccator and weighed at room temperature to get the weight of the ash.

Carbohydrate determination: The carbohydrate content was determined by subtracting the summed up percentage compositions of moisture, protein, lipid, fibre, and ash contents from 100 (Otiotoju, 2009).

Determination of phytate: Spectrophotometric method was used in the determination of phytate. 1g of the pulverized *Solanum* sample was dissolved in 25 ml of 0.5 M HNO₃ and centrifuged at 4,000rpm for 10 min. 1 ml of 0.03 M Ferric solution was added to the supernatant and left to stand for 15 min in order to allow chelation of the iron molecules by the indigenous plant phytate. At the end of the incubation, it was capped and heated for 20 min, 7.5 ml of distilled water was added to it and vortexed. Thereafter, 0.1 ml of 1.33 M NH₄SCN (Ammonium sulphocyanide) solution was added and absorbance read at 465nm. The amount of phytate was extrapolated from a standard calibration curve for calcium phytate.

Determination of oxalate: The titrimetric method of Day & Underwood (1986) was used in the determination of oxalate in the two *S. melongena* varieties. 150 ml of 15 N H₂SO₄ was added to 5 g of the pulverized *Solanum* sample and the solution was carefully stirred intermittently with a magnetic stirrer for 30 minutes and filtered using Whatman No 1 filter paper, after which 25 ml of the filtrate was collected and titrated against 0.1 N KMnO₄ solution until a faint pink color appeared that persisted for 30 seconds.

Determination of saponin: Saponin composition was determined using the gravimetric method of Hudson & El-Difrawi (1979). Two hundred and twenty millilitres of 20% ethanol was added to 10 g of the pulverized *Solanum* samples and stirred using a magnetic stirrer for 12 hours at 55° C. The solution was filtered using Whatman No 1 filter paper and the extract was reduced to 40 ml under vacuum and 20 ml Diethyl ether was added in a separating funnel and shaken vigorously. The ether layer was discarded while the pH of the aqueous solution was adjusted to 4.5 by adding NaOH. 60 ml of n-butanol was finally used for extraction. The Butanol extract were washed twice with 10ml of 5 % NaCl and evaporated to dryness in a fume cupboard to give a crude saponin which was weighed.

Determination of alkaloid: Alkaloids were determined by gravimetric method of Harborne (1973). Five grammes of the pulverized *Solanum* samples were weighed into a conical flask containing 50 ml of 10 % ammonium hydroxide, the mixture stirred and allowed to stand for 4 hours, before filtering. The filtrate was evaporated to one quarter of its original volume on a hot plate and concentrated ammonium hydroxide solution was added drop-wise to the mixture in order to precipitate the alkaloids. The precipitate was filtered using a weighted filter paper and washed with 10 % ammonium hydroxide solution. The precipitate was dried with the filter paper in an oven at 60 ° C for 30 minutes and then re-weighed.

Determination of tannin: Spectrophotometric method of Trease & Evans (1989) was used in the determination of tannin in the two varieties of *S. melongena*. Five grammes of the powdery form of *Solanum* samples were extracted with 20ml of warm water and filtered. 0.5ml of the filtrate was added to 0.5 ml of 0.5M ferric solution in an alkaline medium and allowed to stand for 30 minutes for color development. The absorbance was read at 760 nm and the amount of tannin was extrapolated from a standard calibration curve for tannic acid.

Determination of mineral content: The method of A.O.A.C (1990) was employed for the determination of mineral content. One gramme of the of the pulverized *Solanum* samples was placed in a crucible and ignited in a muffle furnace at 550°C for 6 hours. The resulting ash was dissolved in 10 ml of 10 % HNO₃ and heated slowly for 20 minutes. After heating, it was filtered and the filtrate was used for the determination of mineral content. Atomic absorption spectrophotometer (AAS) was used to determine Ca, Mg, Fe, P and Zn, while flame photometer was used for the determination of Na and K in the filtrate.

Statistical analysis: Analysis of variance of data was evaluated by the statistical analysis system (INSTAT Software). Tukey-Kramer multiple comparison test was employed (INSTAT Software) to determine the statistical differences among the means.

RESULTS

The nutritional analysis of the unripe fruits of the two varieties of *Solanum melongena* revealed very high moisture contents, ranging from 78.44 ± 0.49 % in the round variety to 72.93 ± 0.76 % in the oval variety. There was a significant difference (P < 0.01) in the moisture contents of both varieties, with the round variety having a higher value (Table 1). The protein and fibre contents were higher in the round variety of *S. melongena* (5.79 ± 0.22 % and 1.81 ± 0.86 % respectively) compared to the oval variety. Whereas, the lipid, ash and carbohydrate contents were lower in the same variety (1.65 ± 0.62%, 1.96 ± 0.12% and 11.77 ± 1.55 % respectively) compared to the oval variety. All these parameters showed no significant differences (P > 0.01) in both varieties (Table 1).

Analyses of the mineral contents showed that calcium, iron, sodium and nitrogen were higher in the round variety of *Solanum melongena* while magnesium, phosphorus and potassium were higher in the oval variety. The zinc contents were the same in both varieties (Tables 2 & 3). Phytochemical analysis revealed that the levels of phytate, oxalate, alkaloid and tannin were higher in the round variety of *Solanum melongena* compared to the oval variety. However, the saponin content was higher in the oval variety than in the round variety (Table 4).

TABLE 1. NUTRITIONAL ANALYSIS OF TWO VARIETIES OF *Solanum melongena*.

SAMPLE	MOISTURE	PROTEIN*	LIPID*	FIBRE*	ASH*	CARBOHYDRATE*
<i>Solanum melongena</i> (round variety)	78.44 ± 0.49 ^a	5.79 ± 0.22 ^a	1.65 ± 0.62 ^a	1.81 ± 0.86 ^a	1.96 ± 0.12 ^a	11.77 ± 1.55 ^a
<i>Solanum melongena</i> (oval variety)	72.93 ± 0.76 ^b	4.58 ± 0.40 ^a	2.13 ± 1.49 ^a	1.78 ± 0.13 ^a	3.15 ± 1.54 ^a	15.42 ± 0.69 ^a

* % Dry matter. Values are means ± SEM for three replications. Means with the same letter on the same column are not significantly different at P < 0.01.

TABLE 2. MINERAL CONTENTS OF TWO VARIETIES OF *Solanum melongena*.

SAMPLE	CALCIUM*	IRON*	MAGNESIUM*	PHOSPHORUS*	ZINC*
<i>Solanum melongena</i> (round variety)	3.68 ± 0.02 ^a	2.75 ± 0.01 ^a	2.26 ± 0.03 ^a	3.72 ± 0.21 ^a	0.25 ± 0.001 ^a
<i>Solanum melongena</i> (oval variety)	1.95 ± 0.03 ^b	1.96 ± 0.06 ^b	2.56 ± 0.01 ^b	5.23 ± 0.04 ^b	0.25 ± 0.006 ^a

*mg/100 g. Values are means ± SEM for three replications. Means with the same letter on the same column are not significantly different at P < 0.01.

TABLE 3. MINERAL CONTENTS OF TWO VARIETIES OF *Solanum melongena*.

SAMPLE	SODIUM*	POTASSIUM*	NITROGEN**
<i>Solanum melongena</i> (round variety)	184.21±0.52 ^a	238.10±1.21 ^a	0.93± 0.02 ^a
<i>Solanum melongena</i> (oval variety)	174.93±0.43 ^b	245.37± 0.27 ^b	0.73± 0.01 ^b

*mg/100 g. ** % Values are means ± SEM for three replications. Means with the same letter on the same column are not significantly different at P < 0.01.

TABLE 4. PHYTOCHEMICAL OF TWO VARIETIES OF *Solanum melongena*.

SAMPLE	PHYTATE*	OXALATE*	ALKALOID*	TANNIN*	SAPONIN*
<i>Solanum melongena</i> (round variety)	28.19±0.15 ^a	41.72±0.6 ^a	1.16±0.09 ^a	12.82±0.14 ^a	5.34±0.31 ^a
<i>Solanum melongena</i> (oval variety)	18.67±0.4 ^b	23.97±0.5 ^b	0.99±0.0 ^b	11.34±0.48 ^b	11.63±0.29 ^b

* mg/100 g. Values are means ± SEM for three replications. Means with the same letter on the same column are not significantly different at P < 0.01.

DISCUSSION

The nutritional analysis of the two varieties of *Solanum melongena* showed low carbohydrate contents and the lowest (11.77 ± 1.55%) was found in the round variety. Lower glucose levels have also been reported in the round variety of *S. melongena* compared to the oval variety in all the ripening stages (Agoreyo & Oghene, 2011). These low carbohydrate and glucose levels make *S. melongena* varieties, especially the round variety, useful to those who are diabetic and individuals who are watching their weight.

Lipid levels were also low in the two varieties of *S. melongena* with the round variety having the lowest level (1.65 ± 0.62 %). *Solanum* species (eggplants) have been reported to reduce LDL/HDL ratio and increase HDL/LDL ratio in hypercholesterolemic rabbits (Igwe *et al.*, 2003; Odetola *et al.*, 2004). They are ideal fruits for individuals with increased serum lipid levels, high blood pressure and other ischemic heart diseases.

The levels of protein in the two varieties of *Solanum melongena* were not too high; however the protein content of the round variety (5.79 ± 0.22 %) was higher than that of the oval variety (4.58 ± 0.40 %). Nitrogen content was also not too high in both varieties and it correlated with that of protein. Since these eggplants are eaten as fruits, their protein contents could be used to supplement the proteins from staple food.

Although the fibre contents of the two *Solanum melongena* varieties were low, with the round variety having a higher level; these fibre contents together with the low carbohydrate contents found in these fruits are good in the management of diabetes mellitus.

The high moisture content of these *S. melongena* varieties makes them susceptible to infection by micro-organisms; however the fibrous nature of their skin makes it a little bit difficult for microorganism to penetrate unlike that of pawpaw. This tends to make the shelf life of *S. melongena* longer than that of pawpaw (Agoreyo *et al.*, 2003).

Minerals content analysis revealed that calcium and iron that are required for bone development and haemoglobin production respectively (Nelson and Cox, 2005; Helena, 2008) were higher in

the round variety of *S. melongena*. Magnesium which plays a vital role in the activity of many enzymes was higher in the oval variety, the same thing applied to phosphorous that is an important component of energy intermediates (Vance *et al.*, 2003).

Zinc that is required for the proper functioning of the reproductive system (Hambidge, 2006) was found to be present in the same amount in both varieties of *S. melongena*. Sodium was also observed to be lower than potassium in both varieties of *S. melongena*. Low sodium diet has been reported to be beneficial in the prevention of high blood pressure (Lichtenstein, 2006) and high potassium has been reported to have a protective effect against excessive sodium intake.

The phytochemical analysis showed that phytate, oxalate, alkaloid and tannin were higher in the round variety of *S. melongena* than the oval variety. Although phytate and oxalate can bind calcium, magnesium iron and zinc making them unavailable, but their levels were not high in both varieties of *S. melongena*. saponin was higher in the oval variety than the round variety. Alkaloids, tannins and saponins have been reported to have medicinal properties. The presence of these phytochemical constituents showed that the two *S. melongena* varieties have medicinal property. Sofowora (1993) reported the roles of these phytochemicals as analgesic, anti-inflammatory, anti-hypertensive and anti-microbial. Saponins and tannins also exhibit cytotoxic effects and growth inhibition making them suitable as tumor inhibiting agents (Akindahunsi & Salawu, 2005; Asl & Hossein, 2008).

REFERENCES

- Agoreyo, B. O., Obuekwe, I. F. & Osondu, E. E. (2003). Analyses of the biochemical constituents and microbiological changes in pawpaw (*Carica papaya*) fruits at different ripening stages. *African Journal of Agricultural Research*, 1: 133-138.
- Agoreyo, B. O. & Oghene, O. A. (2011). Changes in the glucose level of eggplant species during ripening. *Journal of Medical and Biomedical Research*, 10: 12-6.
- Akanitapichat, P., Phraibung, K., Nuchklang, K. & Prompitakul, S. (2010). Antioxidant and hepatoprotective activities of five eggplant varieties. *Food and Chemical Toxicology*, 48: 3017-3021.

Akindahunsi, A. A. & Salawu, S. O. (2005). Phytochemical screening and nutrient composition of selected tropical green leafy vegetables, *African Journal of Biotechnology*, 4: 497-501.

A.O.A.C., (1990). Association of Official Analytical Chemists. Official Methods of Analysis of the AOAC, 15th Edn., Washington, D.C.

Asl, M. N. & Hossein, H. (2008). Review of Pharmacological Effects of Glycyrrhiza sp. and its Bioactive compounds. *Phytotherapy Research*, 22: 709-724.

Bello, S. O., Muhammed, B. Y., Gammaniel, K. S., Abdu-Ayugel, K. S., Ahmed, H., Njoku, C. H., Pindiga, U. H. & Salka, A. M. (2005). Preliminary evaluation of the toxicity and some Pharmacological properties of Aqueous crude extract of *Solanum melongena* *Research Journal of Agricultural and Biological Sciences*, 1 :1-9.

Bonsu, K. O., Fontem D. A., Nkansah, G. O., Iruome R. N., Owusu E. O., & Schippers R. R. (2008). Diversity within the Gboma eggplant (*Solanum macrocarpon*), an indigenous vegetable from West Africa. *Ghana Journal of Horticulture* 1:50-58.

Chinedu, S. N., Olasumbo, A. C., Eboji, O. K., Emiloju, O. C., Arinola, O. K. & Dania, D. I. (2011). Proximate and phytochemical analysis of *solanum aethiopicum* L and *Solanum Macrocarpon* L. fruits. *Research Journal of Chemical Sciences* 1: 63-71.

Day, J. R. A. & Underwood, A. L. (1986). *Quantitative Analysis* 5th Ed., Prentice-Hall publications, London. p701.

Edem, C. A., Dounmu, M. I. Bassey, F. I., Wilson, C. & Umoren, P. (2009). A comparative Assessment of the proximate composition, Ascorbic Acid and Heavy metal content of two species of Garden egg (*Solanum gilo* and *Solanum aubergine*). *Pakistan Journal of Nutrition*, 8(5): 582-84.

FAO (1980). Compositional Analysis methods In: Manuals of food quality control. Food analysis, general techniques, additives, contaminants and composition of food and Agricultural organization of the United Nations Pp. 203-232.

Gill, L. S. (1992). *Ethnomedical uses of plants in Nigeria*. University of Benin Press. Benin, Nigeria. P.215.

Hambidge, M. (2006). Human zinc deficiency. *Journal of Nutrition*, 130:1344S-1349S.

Harborne, J. B. (1973). *Phytochemical Methods*. Chapman and Hall Ltd, London. Pp. 149-188.

Helena, E. (2008). Iron imbalance can lead to clinical depression *Journal of Health and Fitness*, 42: 48-102.

Hudson, B. J. F. & El-Difrawi, E. A. (1979). The sapogenins of the seeds of four Lupin species. *Journal of Plant Foods*, 3:181-186.

Igwe, S. A., Akunyili, D. N. & Ogbogu, C. (2003), Effects of *Solanum melongena* on some visual functions of visually active Igbos of Nigeria, *Journal of Ethnopharmacology* 86:135-138.

Lichtenstein, A. H., Appel, L. J., Brands, M., Camethon, M., Daniels, S., Franch, H. A., Franklin, B., Kris-Etherton, P., Harris, W. S., Howard, B., Karanja, N., Lefevre, M., Rudel, L., Sacks, F., Van Horn, L., Winston, M. & Wylie-Rosett, J. (2006). Summary of American heart association diet and lifestyle recommendations revision. *Arteriosclerosis, Thrombosis and Vascular Biology*, 26: 2186-2191.

Manoko, M. L. K., van der Weerden, G. M. (2004) *Solanum americanum* In: G. J. H. Grubben and O. A. Denton (eds.), *Plant Resources of Tropical Africa 2. Vegetables*. PROTA Foundation Wageningen / CTA Wageningen, Backhuys Publishers, Leiden, the Netherlands, pp. 477-480.

Nelson, D. L. & Cox, M. M. (2005). *Lehninger Principle of Biochemistry*, 4th ed. W.H. Freeman.

Odetola, A. A., Iranloye, Y. O., & Akinloye, O. (2004). Hypolipidemic Potentials of *Solanum melongena* and *Solanum gilo* on Hypercholesterolemic Rabbits. *Pakistan Journal of Nutrition*, 3: 180-187.

Otitoju, G. T. O. (2009). Effect of dry and wet milling processing techniques on the nutrient composition and organoleptic attributes of fermented yellow maize (*Zea mays*) *African Journal of Food Sciences*, 3: 113-116.

Sofowora, A. (1993). *Medicinal Plants and Traditional Medicine in Africa* Spectrum Books Ltd. Ibadan Nigeria. Pp. 191 – 289.

Trease, G. E. & Evans W. C. (1989), *Pharmacognosy*, 13th. Braillière Tindall, London p.290.

Vance, C. P., Uhde-Stone, C. & Allan, D. L. (2003). Phosphorus acquisition and use: critical adaptations by plants for securing a nonrenewable resource. *New Phytologist* 157: 432–449