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RESEARCH PAPER**EFFECT OF CUCUMBER CONSUMPTION ON PLASMA CREATININE, UREA, URIC ACID AND GLUCOSE LEVEL IN APPARENTLY HEALTHY STUDENTS OF COLLEGE OF HEALTH SCIENCES, NNAMDI AZIKIWE UNIVERSITY, NNEWI CAMPUS, ANAMBRA STATE, NIGERIA*****Ogbodo EC¹, Ezeugwunne IP^{1,2}, Analike RA^{1,3}, Ezeodili VK¹, Egbe JU¹, Obiorah MO¹, Aguta UE¹, Madukwe DUP⁴, Nwanko JC¹, Onah CE³, Ugwu MC¹, Meludu SC^{1,2}.**¹Department of Chemical Pathology, NnamdiAzikiwe University, Nnewi Campus; ²Department of Human Biochemistry, NnamdiAzikiwe University, Nnewi Campus; ³Department of Chemical Pathology, Nnamdi Azikiwe University Teaching Hospital, Nnewi; ⁴Department of Histopathology, Nnamdi Azikiwe University, Nnewi Campus.*Corresponding Author's Email: augustinee442@gmail.com; destinychild016@gmail.com**Published: 31st March, 2017***Endorsed By: Innovative Science Research Foundation (ISREF) and International Society of Science Researchers (ISSCIR).**Indexed By: African Journal Online (AJOL); Texila American University; Genamics; Scholarsteer; EIJASR; CAS-American Chemical Society; and IRMS Informatics India (J-Gate)***ABSTRACT**

This study was designed to investigate the effect of oral intake of cucumber on plasma creatinine (Cr), urea, uric acid (Ua) and blood glucose in young apparently healthy students. A total of 29 subjects (14 males and 15 females) were recruited. Each subject was advised to abstain from cucumber and similar vegetables consumption for two weeks. Thereafter, they received 400 g of whole cucumber for 21 days prior to their daily breakfast. 5mls each of baseline (day zero) and post consumption (day 22) samples were collected after overnight fast into fluoride oxalate and lithium heparin containers for glucose and other biochemical parameters respectively. Plasma glucose, urea, creatinine and uric acid were analyzed using standard methods. There was a significant decrease in the mean plasma glucose level in post cucumber consumption when compared to the pre-cucumber consumption (4.28 ± 0.46 vs 4.68 ± 0.35 ; $p < 0.05$). However, plasma levels of urea, uric acid and creatinine did not differ significantly between pre and post-cucumber consumption. This study revealed hypoglycaemic effect of cucumber consumption with no harmful effect on the kidney. Therefore, cucumber consumption could be of importance in prevention and management of diabetes mellitus.

Keywords: Cucumber, urea, glucose, Uric acid, Creatinine.**INTRODUCTION**

The use of plants as source of remedies for the treatment of diseases can be traced back to the prehistoric times (Lawrence and Bennett, 1995; Evans, 2009; Ankita *et al.*, 2012) and medicinal herbs are being increasingly studied by pharmacological researchers (Sinclair, 1998). Indian Ayurveda medicine used herbs as early as 1900BC describing about 700 medicinal plants (Aggarwal *et al.*, 2007). According to the World Health Organization (WHO) more than 80% of the world's populations, rely on traditional medicine for their primary health care, majority of which use plants or their active principles (Gupta *et al.*, 2005).

The use of plant resources mainly for herbal medicine, food, forages etc in Nigeria represents a long history of human interaction with the environment and their invitro and invivo properties to microbial pathogens have been widely reported (Hashish and Gomaa, 2003; Iwalokun *et al.*, 2004). Cucumber (*Cucumis sativus*) belongs to the family cucurbitaceae. In general, there are 118 genera and 825 species worldwide (Rai *et al.*, 2008) among which 30 cucumis species are found in Asia and African. Plants of this family have many medicinal and nutritional benefits (Gill and Bali, 2011). The medicinal value of these plants lies in some chemical substances that produce a definite physiological action on the human body (Edeoga *et al.*, 2005). These chemicals are termed as phyto-chemicals. Egypt is the largest African producer. Research has shown the presence of the phytochemical called terpenoids in Cucumissativus extract (Ankita *et al.*, 2012). Terpenoids are



known to possess medicinal potency against malaria, viral, bacterial and fungal agents (Malik *et al.*, 2013; Egwaikhide, 2010; Akther, 2012).

Studies have shown the antioxidant effect of *C. sativus* in rats (Gill *et al.*, 2009), substantial anti-inflammatory activity, anti-ulcer effect (Gill *et al.*, 2009), saponins have hemolytic property, induced cytotoxicity effect (Rao and Sung, 1995), antitumor and anti-mutagenic activities and can lower the risk of human cancers, by preventing cancer cells from growing (Nafiu *et al.*, 2011).

MATERIALS AND METHODS

Study Area: Nnamdi Azikiwe University, Okofia-Otolo, Nnewi campus comprises the college of Health Sciences having the faculties of Basic Medical Sciences, Health Sciences and Technology and Medicine. It is located in the suburb of Nnewi - a popular town in Anambra State Nigeria. The environment is poorly developed and lacking basic amenities such as housing, road, communication, electricity and potable water compared to campuses located in urban areas.

Study Design: A total of 29 subjects (14 males and 15 females) between 18 and 28 years old were recruited. The subjects were essentially medical students. Each subject was advised to abstain from cucumber and similar vegetables consumption for two weeks. Thereafter, they received 400g of whole cucumber for 21 days prior to their daily breakfast. 5mls each of baseline (day zero) and post consumption (day 22) samples were collected after overnight fast into fluoride oxalate and lithium heparin containers for glucose and other biochemical parameters respectively. Plasma glucose, urea, creatinine and uric acid were analyzed using standard methods described by Bergmeyer and Bernt (1974); Taylor, (1992); Burtis and Carl, (2008) and Trivedi *et al.*, (1978) respectively.

Ethical Consideration: Ethical approval was obtained from the Faculty of Health Sciences and Technology ethical committee, Nnamdi Azikiwe University, Nnewi campus, Anambra State, Nigeria for sample collection.

Inclusion and Exclusion criteria: Apparently healthy male and female Subjects that consume cucumber and are between 18-28 years of age and non-diabetic and not on drugs (hypoglycaemic and diuretic drugs) were recruited for the study. Subjects younger than 18 years or older than 28 years old that do not consume cucumber and other similar vegetables that are on drugs and medications (hypoglycaemic and diuretic drugs) were excluded from this study.

RESULTS

The mean age (years), height (metres), weight (Kg) and body mass index (Kg/m²) were (23.3 ± 2.24 years, 1.63 ± 0.88 m, 62.62 ± 11.11 Kg, and 23.34 ± 3.19 Kg/m²) respectively. The subjects were from young and apparently healthy population. When the anthropometric parameters were compared between the male and female subjects, there was a significant difference in the mean age and height of the male than female subjects. However, there was no significant difference in the mean weight of both sexes and in general, no significant difference in mean body mass index (BMI) of the subjects compared. (P < 0.05), (See Table 1).

The result showed that plasma concentrations of the renal parameters (creatinine, urea and uric acid) were similar pre- and -post cucumber consumption. However, the plasma glucose concentration was significantly decreased after 3 weeks of cucumber consumption compared to the pre-consumption. (See table 2).

There were significant differences in the mean plasma creatinine and uric acid levels of the males when compared to female subjects before cucumber consumption. However, there were no significant difference in the mean plasma electrolyte levels, urea and glucose when compared before cucumber consumption (p < 0.05). (See table 3 and 4).

There were no significant differences in the mean plasma levels of all parameters compared between both sexes, but there was significant positive correlation between all the parameters (uric acid, urea and creatinine compared in the post-cucumber consumption in the apparently healthy subjects (p < 0.05). (See table 5 and 6).



Table 1 The Anthropometric Parameters of Subjects Studied (Mean±SD; n=29).

Parameters	All Subjects (n=29)	Male (n=14)	Female (n=15)	t-value	p-value
Age (year)	23.3±2.4	24±2.4	22.5±2.4	2.122	0.043*
Height (meter)	1.63±0.88	1.69±0.86	1.59±0.62	3.526	0.002*
Weight (Kg)	62.62±11.11	65.79±8.85	59.67±12.42	1.534	0.137
BMI (Kg/m ²)	23.34±3.19	23.6±2.59	23.51±3.57	0.296	0.770

*Statistically significant at P<0.05

Table 2 Renal parameters and fasting blood glucose before and after 3weeks of cucumber consumption.

Variables	Pre-cucumber Consumption	Post-cucumber Consumption	t-value	p-value
Plasma creatinine (umol/l)	67.22±22.46	63.05±42.46	0.976	0.337
Plasma urea (mmol/l)	4.04±0.81	4.14±1.43	0.660	0.515
Plasma uric acid (mmol/l)	222.31±69.59	232.61±53.81	0.370	0.715
Fasting blood Glucose (mmol/l)	4.68±0.35	4.28±0.46	3.770	0.001*

*Statistically significant at P<0.05

Table 3 Renal Parameters and Fasting Blood Glucose of male and female participants before cucumber consumption.

Variables	Males (n=14)	Females (n=15)	t-value	p-value
Plasma creatinine (umol/l)	76.62±20.80	58.20±20.89	2.347	0.027*
Plasma urea (mmol/l)	4.04±0.76	4.05±0.88	0.058	0.954
Plasma uric Acid (mmol/l)	253.40±59.59	193.29±67.22	2.522	0.017*
Fasting blood glucose (mmol/l)	4.71±0.35	4.65±0.36	0.451	0.656

*Statistically significant at P<0.05.



Table 4 Renal Parameters and Fasting Blood Glucose of participants after 3weeks of cucumber consumption.

Variables	Males (n=14)	Females (n=15)	t-value	p-value
Plasma creatinine (umol/l)	64.02+15.96	62.14+15.39	0.323	0.749
Plasma urea (mmol/l)	4.27+1.91	4.03+0.84	0.442	0.664
Plasma uric Acid (mmol/l)	232.42+57.56	232.79+52.09	0.018	0.986
Fasting blood glucose (mmol/l)	4.23+0.48	4.32+0.46	0.528	0.602

*Statistically significant at P<0.05

Table 5 the levels of Association between Parameters Studied before cucumber consumption.

Parameters	Subjects(n)	Correlation Coefficient Pearson r	p-value
Ht Vs Wt	29	0.642	0.000*
Wt Vs BMI	29	0.802	0.000*
Ua Vs Cr	29	0.651	0.000*

* Statistically significant at P<0.05.

Table 6 The levels of Association between Parameters Studied Post cucumber consumption

Parameters	Subjects(n)	Correlation Coefficient Pearson r	p-value
Ht Vs Wt	29	0.642	0.000*
Wt Vs BMI	29	0.802	0.000*
Ua Vs Urea	29	0.396	0.033*
Ua Vs Cr	29	0.492	0.007*

* Statistically significant at P<0.05. Ht=height; Wt=weight

DISCUSSION

Cucumis sativus (Cucumber) has been found as a suitable functional food for medicinal purposes such as diabetes, hyperlipidemia, hypertension (as diuretic), gall bladder stones, constipation and dyspepsia in Asian Traditional Medicine (Trease *et al.*, 2002).



In this study cucumber consumption significantly reduced plasma glucose concentration in apparently healthy subjects. This result confirms the report of Mohsen *et al.*, (2011) who investigated the effect of hydroalcoholic and Buthanolic extract of *C. sativus* seed on blood glucose level of normal and streptozotocin- induced diabetic rats and found that both hydroalcoholic (22-33.8%) and Buthanolic (45.0%) extract of *C. sativus* were effective in reducing blood glucose level and controlling the loss of body weight in diabetic rats after nine days of continued daily therapy. Other similar studies in rats also did show the reducing effect of *C. sativus* on blood glucose levels (Dixit and Kar, 2010; Agarwal *et al.*, 2007; Sharmin *et al.*, 2013; Banshidhar and Deepmala, 2013; Stano *et al.*, 2002). The decreased level of fasting blood glucose in post cucumber consumption in the apparently healthy subjects maybe as a result of its stimulation of insulin release from the pancreatic-beta –cells or its release from the bound form (Davis *et al.*, 2002; Mahome and Ojewole, 2003; Nolte *et al.*, 2004; Banshidhar and Deepmala, 2013). Furthermore, there may have been stimulation of peripheral glucose utilization or enhancing glycolytic and glycogenic processes with concomitant decrease in glycogenolysis and gluconeogenesis (Andrade-cetto and Wiedefeld, 2004). In addition, the antihyperglycemic activity of cucumber may also be due to the presence of hypoglycemic Saponins, Tannins, Triterpines, Alkaloids, Flavonoids e.t.c (Sparg *et al.*, 2004; Sahu *et al.*, 2008).

Interestingly, cucumber consumption had no significant effects of renal parameters/functions in the total population. Out of all the parameters studied, the mean plasma creatinine level was significantly higher in the males compared to female subjects prior to the consumption of cucumber. This significant increase in the mean plasma creatinine level in the male than female subjects may be due to higher muscle mass in the male subjects. Creatinine production is proportional to skeletal muscle mass. Men tend to have higher levels of creatinine than women because they generally have a greater mass of skeletal muscle (Taylor and Howard, 1989). Eating a lot of meat can increase daily creatinine (Taylor and Howard, 1989). However, following cucumber consumption the difference was no longer significant. In contrast, in previous studies it was observed that there was a significant increase in the plasma creatinine level following the investigation of the potential of the alcoholic extract of *Cucumis sativus* as an antiurolithialic agent in male and female rats which were calculi-induced (Krishnaveni *et al.*, 2013 and Tushar *et al.*, 2014).

The present study shows a significant increase in the mean plasma uric acid level in the male than female subjects in the post cucumber consumption period. This confirms the work of Krishnaveni *et al.*, (2013) who showed that there was a significant increase in the mean plasma uric acid level in rats after investigating the potential of the alcoholic extract of *cucumis sativus* as an antilithialic agent in male and female rats that were calculi- induced. This increase in the mean plasma uric acid level may be as a result of the gender variation (Taylor and Howard, 1989).

This research indicates that there is a positive correlation between height and weight of the subjects before and after cucumber consumption. Report has it that there is a significant decrease in weight after cucumber consumption (Szalay, 2015). The weight versus body mass index (BMI) indicates a positive correlation before and three weeks post cucumber consumption. This means that as the weight of the body increases, the body mass index increases too.

There was a positive correlation between the plasma uric acid versus creatinine as well as in urea versus creatinine both before and after cucumber consumption. This perhaps explains the fact that they are both indicators of kidney function and are continually maintained within a reference limit in healthy subjects (Jacki *et al.*, 2007; Harrita, 2009; Amed, 2011; Allen, 2012). Accumulation of these metabolites in the blood indicates renal disorder (Sarnak *et al.*, 2003; Perazella and Klan, 2006; Appel *et al.*, 2008).

CONCLUSION

From the current study, we conclude that cucumber has significant antihyperglycemic effects and is able to keep the body hydrated. Therefore, cucumber can be useful, at least as an adjunct, in the therapy of diabetes, a condition in which hyperglycemia and hyperlipidemia coexist quite often. However, further study is necessary for the screening of chemical compounds and the structure elucidation of the respective antidiabetic property as well as their extraction mechanism.

RECOMMENDATIONS

Based on our findings, we recommend that adequate nutritional and health education strategies should be adopted to enlighten the general public on the beneficial effects of cucumber. Cucumber can be used in the management of Diabetes Mellitus. Further studies should be carried out to fully understand the full benefit of cucumber consumption.



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REFERENCES

- Aggarwal, B.B., Sundaram, C., Malani, N. and Ichikawa, H. (2007). Curcumin, the Indian Solid Gold. *Journal of Advanced Experimental Medical Biology*; 595:1-75.
- Ahmed, N. (2011). In *Clinical Biochemistry*. 2nd Edition. Oxford University Press. New York. Page 72.
- Allen, P.J. (2012). Creatine metabolism and psychiatric disorders: Does creatine supplementation have therapeutic value? *Neuroscience Biobehavioural*; 36 (5): 1442–1462.
- Andrade-Cetto, A. and Wiedenfeld, H. (2004). *Journal of Ethnopharmacology*; 90: 217. <http://dx.doi.org/10.1016/j.jep.2003.09.049>
- Ankita, S., Kaur, P., Gupta, R. (2012). Phytochemical screening and antimicrobial assay of various seeds extracts of Cucurbitaceae Family. *International Journal of Applied Biology and Pharmaceutical Technology*; 3 (3) 401-409.
- Appel, L.J., Wright, J.T., Greene, T. (2008). Long-term effects of renin-angiotensin system-blocking therapy and a low blood pressure goal on progression of hypertensive chronic kidney disease in African Americans. *Archives Internal Medicine*; 168 (8): 832–839.
- Banshidhar and Deepmala. (2013). Current Researches on Plants having Antidiabetic Potential. *Journal of Botanical Science*; 2(2): 4-17.
- Bergmeyer, H.U., Bernt, E. (1974). Determination of glucose with glucose oxidase and peroxidase. In: HU Bergmeyer (Ed.), *Methods of enzymatic analysis*, Verlag Chemie-Academic Press, New York: 1205-1215.
- Burtis, Carl, A. (2008). *Tietz Fundamentals of Clinical Chemistry*, 6th ed. Saunders: St Louis, Missouri.
- Davis, S.N and Granner, D.K. (2002). Insulin oral hypoglycemic agents, and the pharmacology of the endocrine pancreas. In: Hardman JG, Limbird LE, Gilman AG, editors. *Goodman and Gilman's the pharmacological basis of therapeutics*. 10th ed. New York: McGraw Hill Companies; pp. 1687–1690.
- Dixit, Y. and Kar, A. (2010). Protective role of three vegetable peels in alloxan-induced diabetes mellitus in male mice. *Plant Foods of Human Nutrition*; 65:284–289.
- Edeoga, H.O., Okwu, D.E., and Mbaebie, B.O. (2005). Phytochemical constituents of some Nigerian medicinal plants. *African Journal of Biotechnology*; 4 (7) 685-688.
- Egwaikhide, P.A., Bulus, T. and Emua, S.A. (2010). Antimicrobial activities and phytochemical screening of extracts of the fever tree, *Eucalyptus globulus*. *Electronic Journal of Environmental, Agricultural and Food Chemistry*; 9 (5) 940-945.
- Gill, N.S., and Bali, M. (2011). Isolation of antiulcer Cucurbitane type triterpenoid from the seeds of *Cucurbita pepo*. *Research Journal of Phytochemistry*; 5 (2) 70-79.
- Gill, N.S., Garg, M., Bansal, R., Sood, S., Muthuraman, A., Bali, M., and Sharma, P.D. (2009). Evaluation of antioxidant and antiulcer potential of *Cucumis sativum* L. seed extract in rats. *Asian Journal of Clinical Nutrition*; 1 (3) 131-138.



Gupta, M.P, Solís, P.N., Calderón, A.I., Guinneau-Sinclair, F., Correa, M., Galdames, C., Guerra, C., Espinosa, A., Alvenda, G.I., Robles, G. and Ocampo, R. (2005). Medical ethnobotany of the Teribes of Bocas del Toro, Panama. *Journal of Ethnopharmacology*; 96:389-401.

Harita, N., Hayashi, T., Sato, K. (2009). Lower serum creatinine is a new risk factor of type 2 diabetes: the Kansai healthcare study. *Diabetes Care*; 32(3): 424-426.

Hashish, M.N. and Gomaa, N.F. (2003). The inhibitory effects of garlic (*Allium sativa*) on growth of some microorganisms. *Journal of Egyptian Public Health. Association*; 78(5-6):361-372.

Iwalokun, B.A., Ogunledun, A., Ogbolu, D.O., Bamiro, S.B., Jimi- Omojola, J. (2004). *In-vitro* antimicrobial properties of aqueous garlic extract multi-drug resistant bacteria and *Candida* species from Nigeria. *Journal of Medicinal Food*; 7(3):327-333.

Jacki, B. and Thomas, B. (2007). *Manual of Dietetic Practice*. 1st Edition. Wiley-Blackwell. Page 76.

Jayashree, V.C., Anil, H.U. (2015). Rich Source of Nutraceutical: CucumisSativus (Cucumber). *International Journal of Ayurveda and Pharmacological Research*; 3(7):93-96.

Jessie ,S. .(2015). Live Science Contributor. Cucumbers health benefits and nutrition facts. www.livescience.com/51000-cucumber-nutrition.html

Jony M., Priyanka D., Saurav D.(2013).Pharmacological Activity of C.sativus L. *American Journal of Pharmaceutical Research and Development*; 1(1):232-244.

Jony, M., Priyanka, D., Sourav, D. (2013). Pharmacological activity of Cucumissativs L.-A complete overview. *Asian Journal of Pharmaceutical Research and Development*; 1(1):2320-4850.

Krishnaveni, J., Rajkiran, E., Manjula, P. and Sudheer, K.D.(2013). Antiuro lithiatic activity of Cucumis sativus. *International Journal of Pharmacological Screening Methods*; 3(2):46-52.

Lawrence, D.R. and Bennett, P.N., (1995). *Clinical Pharmacology* ELBS with Churchill Livingstone, Edinburgh, p. 686.

Malik, J., Akther, R. (2012). Phytochemical Screening and In-Vitro evaluation of Reducing power, Cytotoxicity and Antifungal activities of Ethanol Extracts of Cucumissativus. *International Journal of Pharmaceutical and Biological Archives*; 3(3): 555-560.

Mohsen Minaiyan, BehzadZolfaghari, and Amin Kamal. (2011). Effect of Hydroalcoholic and Buthanolic Extract of *Cucumissativus*Seeds on Blood Glucose Level of Normal and Streptozotocin-Induced Diabetic Rats. *Iranian Journal of Basic Medical Sciences*; 14(5):PMC3586845.

Nafiu, Olugbemi, M., Akanji, Adewumi, M., Yakubu, and Toyin, M. (2011). Phytochemical and Mineral Constituents of *Cochlospermumplanchonii* (Hook. Ef. x Planch) Root. *Bioresearch Bulletin*: 342-347.

Nolte, M.S. and Karam, J.H. (2004). Pancreatic hormones and antidiabetic drugs. In: Katzung BG, editor. *Basic and clinical pharmacology*. 9th ed. New York: McGraw Hill Companies; pp. 708.

Perazella, M.A., Khan, S. (2006). Increased mortality in chronic kidney disease: a call to action. *American Journal of Medical Sciences*. 331 (3): 150–153.

Rai, M., Pandey, S., and Kumar, S. (2008). Cucurbit research in India: a retrospect. *Indian Institute of Vegetable Research Varanasi*:285-294.

Rao, A.V., and Sung, M.K.(1995). Saponins as anticarcinogens. *The Journal of Nutrition*; 125(3):717S-724S.



Sahu, N.P., Banerjee, S., Mondal, N.B. and Mandal, D. (2008). Steroidal saponins. In: Fortschritte der ChemieOrganischerNaturstoffe/progress in the chemistry of organic natural products, fortschritte der chemieorganischernaturstoffe/progress in the chemistry of organic natural products, vol 89. Springer, Vienna :45–141

Sarnak, M.J., Levey, A.S., Schoolwerth, A.C. (2003). "Kidney disease as a risk factor for development of cardiovascular disease: a statement from the American Heart Association Councils on Kidney in Cardiovascular Disease, High Blood Pressure Research, Clinical Cardiology, and Epidemiology and Prevention". *Circulation*. 108 (17): 2154–2169.

Sharmin, R., Khan, M. R. I., Akhter, A., Alim, A., Islam, M.A., Anisuzzaman, S.M., Ahmed, M. J. (2013). *Journal of Scientific Research*; 5(1):161-170.

Sinclair, S. (1998). Chinese herbs: a clinical review of Astragalus, Ligusticum.

Sparg, S.G., Light, M.E., Staden, J.(2004). Biological activities and distribution of plant saponins. *Journal of Ethnopharmacology*; 94:219–243.

Stano, J., Mičieta, K., Kovács, P., Neubert, K., Tintemann, H. and Tribulová, N. (2002). *ActaBiotechnologica*; 21(1): 83.

Taylor, E., Howard (1989). Clinical Chemistry. 4th Edition. New York: John Wiley and Sons: 58–62.

Trease, G.E. and Evans, W.C. (2002). Trease and evanspharmacognosy. 15th ed. London: WB Saunders :419–473.

Trivedi, R.C., Rebar, L., Berta, E., Stong, L. (1978). New enzymatic method for serum uric acid at 500 nm. *Clinical Chemistry*; 24:1908.

Tushar, T., Shelke, V. H., Bhaskar, Gunjegaokar, S. M., Antre, R. V. and Jha, U. (2014). A Pharmacological Appraisal of Medicinal Plants with Antilithiatic Activity. *World Journal of Pharmacy and Pharmaceutical Sciences*; 3(7): 447-456.

AUTHORS' CONTRIBUTIONS

All authors (Ogbodo EC, Ezeugwunne IP, Analike RA, Ezeodili, VK, Egbe JU, Obiorah MO, Aguta UE, Madukwe DUP, Nwanko JC, Onah C, Ugwu MC, Meludu SC.) contributed to the completion of this research work and were actively involved in the presentation of this manuscript.

