Original Article   Open Access

Ethnomedicinal Survey of Plants Used as Remedy for Alzheimer's Disease in Ebonyi State, Nigeria

Nduche M. U.
Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State, Nigeria

Abstract

In the inventory, an ethnobotanical survey was carried out to document the plant families, species and parts of plants used in the management of Alzheimer's disease. The result revealed that a total of 45 plant species from 29 families mostly of the Fabaceae (17.24%), Graminae (13.79%), Amaryllidaceae (10.35%) and Laminaceae (10.35%). The commonest plant species identified include; *Zingiber officinale* Roscoe (ginger), *Allium cepa* L. (onion), *Allium sativum* L. (garlic), *Telfaria occidentalis* Hook F (fluted pumpkin), *Manihot esculenta* Crantz, (cassava), *Zea mays* L. (maize), *Cymbopogon citratus* (DC ex Nees) Stapf (lemon grass), *Curcuma longa* L.(turmeric) and *Vitis vinifera* L. (grape). All the plants identified in this inventory have been used by the herbal practitioners and adjudged to be effective. Despite the survey, more research is needed in the extraction and isolation of active chemical constituents in these plants for the formulation of drugs and other pharmaceutical purposes.

Keywords: Ethnobotanical; Survey; Alzheimer's disease; Active compound; Ebonyi state; Nigeria.

1. Introduction

Alzheimer's disease (AD) is a progressive neurodegenerative disease. It is characterized by progressive cognitive deterioration together with declining activities of daily living and behavioural changes. It is the most common type of pre-senile and senile dementia [1]. Alzheimer's disease (AD) is a brain disorder named after a German physician Aloes Alzheimer, who first describe the disease in 1906 [2]. Alzheimer' disease is characterized by memory loss, multiple cognitive impairment, disturbances of functions such as language functions while several neurobehavioral symptoms include apathy, agitations and anxiety [3].

Ageing together with dietary habits are the main risk factor for the development of neurodegenerative diseases. Dementia is one of the types of neurogenerative diseases. As ageing occurs, it leads to the loss of brain function affecting cognitive thinking, memory and behaviour. Alzheimer' disease is a form of Dementia. Pathologically, it is the aggregation of amyloid peptides and protein tau in the brain. These proteins form neurofibrillary tangles which are very toxic to neuronal pathways in the brain [4]. Apart from ageing, deficiency of estrogen is also one of the causes of AD, exposing neuron to toxic insults, such as A- beta, as a result of which post- menopausal women are at a significant risk of developing AD [5, 6]. Epidemiological findings associated other factors to AD prevalence such as low education level, history of head trauma, high caloric diet, sedentary lifestyle and reduced mental and physical activity during late life, vascular disease risk (hypercholesterolaemia, hypertension, atherosclerosis, coronary heart disease, smoking, obesity and diabetes). A small percentage of AD cases is related to family history. These symptoms become noticeable to others but survival can range from four to twenty years, depending on age and other health conditions [7].

According to World Health Organization (WHO), 5% of the men and 6% of women of above the age of 60 years are affected with Alzheimer's type of dementia worldwide. Approximately 4.5 million people in the United States or about 10% of the population over the age of 65 and this number is projected to reach four times by 2050. Every year more than $100 billion is spent for health care in US to treat Alzheimer's disease in primary care settings alone [8].

Alzheimer's disease was ranked 6th killer disease in 2013 in USA, killing over 84,000 above diabetes [7]. An estimated 5.3 million Americans of all ages had AD in 2015. Almost two third of Americans with AD are women. Alzheimer' disease is one of the costliest chronic diseases to the society. Nearly one in every five Medicare dollars is spent on people with AD and other dementias. In 2050, it will be one in every three dollars [7]. In 2006, a study indicated that worldwide, total number of patients with AD was 26.6 million, and by 2050 the number will quadruple [9]. The 2009 reports from Alzheimer' association showed that in US the annual cost for patients with AD and other dementia were estimated to be US$ 148 billion plus US$ 94 billion unpaired care service [10].

Among neurodegenerative disorders, Alzheimer's disease is the most common and affects nearly 2% of the population in industrialized countries. There are currently 5.4 million people diagnosed with Alzheimer's disease in the United States and by mid -century there are expected to be some 16 million people suffering from Alzheimer's at the cost of $1 trillion a year. Worldwide, there are an estimated 27 million people with Alzheimer' disease. AD renders the patient highly dependent and in need of daily accompaniment which leads to familial hardships and elevated health care cost.

Several antioxidants have shown protective roles against AD. These antioxidants include flavonoids, β-carotene, anthocyanidins and isoflavones. These compounds are found in plants. Isoflavones have recently gained

significant attention, it has been shown to improve cognition and memory [11-13]. Flavonoids protect neurons from the amyloid beta induced damages in AD. Flavonoids promotes the nonamyloidogenic alpha- secretase pathway and reduce the formation of amyloid beta- fibrils [14]. The process through which AD degrades the nerve cells is believe to involve certain properties: inflammatory, oxidative damage and most notably the formation of beta- amyloids plaque mental toxicity. Boron enhances the level of estrogen which is a hormone in the body which can be beneficial in short term memory [15-18].

It has been discovered that cur cumin helps the macrophages to clear the amyloid plague in AD. Macrophages are vital to the immune system. They help the body to fight against foreign protein and effectively clear them. Cumin improve uptake and ingestion of the plaque and help the immune system to clear amyloid protein. It also act as anti-inflammatory and antioxidant in Alzheimer's. It also have cholesterol lowering effect. High- fat diet and increased blood cholesterol are linked to increased amyloid plaques by the intracellular accumulation [3].

The people of Ebonyi state of Nigeria employ herbal medicine for the treatment of diseases, though there are hospitals in the state. Several western pharmaceuticals in Nigeria have their origin in plants. Some of these medicinal plant products are taken as light and simple diets, fruits, decoction, extracts, maceration and infusion. This plant product complements health care [19]. An inventory of plants used for the treatment of fertility conditions will assist in the conservation of such plant species and may lead to the isolation of useful ingredients for the production of drugs and other medicinal consumables.

2. Materials and Methods

2.1. Study Site

The survey was done in Ebonyi State is one of the 36 states of Nigeria (Fig 1.). Ebonyi State is located approximately longitude 7.30' and 8.30'E and latitude 5.40' and 6.45'N. It was created on 1/10/1996 with Abakiliki as the state capital. It is bounded by Benue State at the North, Enugu State at the West, Cross-River at the East and Abia State at the South. There are thirteen Local Government Areas (LGAs) in the state. Ebonyi State has a population of about 2,176,947 with a total land area of 5,533 sqkm [20].

Fig-1. Map of Nigeria showing Ebonyi State (shaded portion)

3. Data Collection

Collection of data was done between May, 2015 and February, 2016. The names of the plants used as remedies for Alzheimer's disease were included in the information collected from the field. Semi- structured interview comprising of questionnaires and conversation with 38 traditional herbal practitioners, aged between 35 and 65 years was done in the different zones of the state in the course of the exercise. The plants named in the field were collected and identified in the taxonomic unit of the Department of Plant Science and Biotechnology of Michael Okpara University of Agriculture, Umudike, Abia state.

4. Result

According to table 1, 45 plant species belonging to 29 families were identified (Table 1). Plant families mostly used were Fabaceae (17.24%), Graminae (13.79%), Amaryllidaceae (10.35%) and Laminaceae (10.35%).

S/N	Family	Botanical Name	Common Name	Local Name (Ibo)	Part Used	Active Compound	References
1	Fabaceae	*Acacia greggi*	Cat claw	Odudu Oyibo	Root and stem	Fisetin	41

					bark		
2	Fabaceae	*Butea frondosa* Koenig ex Roxb (BF)	Flame of the forest, parrot tree	Ibusa	Root and stem bark	Cantharidin, fisetin	42
3	Fabaceae	*Gleditsia triacanthos* L.	Thorny locust	Ilokano	Seed (extract)	Fisetin	43
4	Fabaceae	*Glycine max*	Soybean	Akidi	Seed	Flavonoid	54, 55
5	Fabaceae	*Physostigma venenosum* Balf	Calabar bean	Akidi Calabar	Seed	Physostigmine	56
6	Graminae	*Cymbopogon citratus* (DC ex Nees) Stapf	Lemon grass	Achara ehi	Leaves	Glycyrrhizin, glycyrrhetiric acid	31
7	Graminae	*Oryza sativa*	Rice	Osikapa	Seed	Selenium	39, 40
8	Graminae	*Zea mays*	Maize	Oka	Seed	Selenium	39
9	Graminae	*Triticum aestivum* L	Wheat	Oka ugwu	Seed	Selenium	39
10	Amaryllidaceae	*Galanthus nivalis* L	Snow drop	Nishiki	Bulb, flower	Galanthamine	15, 16
11	Amaryllidaceae	*Allium sativum* L.	Garlic	Galic	Leaf (bulb)	Allicin, sallyleysteine	36, 37
12	Amaryllidaceae	*Allium cepa* L.	Onion	Ayo	Leaf (bulb)	Allicin, allyl methyl sulphide	38
13	Laminaceae	*Salvia officinalis* L.	Common sage	Osaragbogo-eze	Aerial part	Acetylcholine esterase inhibitors	23
14	Laminaceae	*Rosmarinus officinalis*	Rosemary	Obiarakara	Leaf (essential oil)	Apigenin, carvacrol, ursolic acid, oleanolic acid, thymol	2
15	Laminaceae	*Collinsonia canadensis* L.	Canada Horsebalm, stone root	Igara	Root	Carvacol, thymol	32
16	Cucurbitaceae	*Cucumis melo* L.	Melon	Egusi	Seed	Glutathione	39
17	Cucurbitaceae	*Telfaria occidentalis* Hook F	Fluted pumpkin	Ugu	Leaf and seed	Omega- 3 fatty acids, choline, folate.	51, 52
18	Rosaceae	*Malus communis*	Apple	Udara oyibo	Fruit	Fisetin, gluthathione	44
19	Rosaceae	*Prunus amydalus* Batsch	Almond	Frutu	Seed (oil from nut)	Omega 3 fatty acids	46
20	Zingiberaceae	*Curcuma longa* L.	Tumeric	Nwandumo	Stem (Rhizomes)	Glutathione,isoxazoles and pyrazoles	27
21	Zingiberaceae	*Zingiber officinale*	Ginger	Jinger	Stem (Rhizomes)	Gingerin, gingerol, zingerone	45
22	Solanaceae	*Solanum lycopersicum* L.	Tomatoes	Tomato	Fruit	Glutathione	39
23	Solanaceae	*Solanum tuberosum* L.	Potatoes	Ji bekee	Root (tuber)	Glutathione	39
24	Asteraceae	*Matricaria reticutita* L.	Chamomile	Ifulu	Aerial part	Glutathione	30
25	Asteraceae	*Carthamus tinctorius* L.	Safflower	Agbara, Ububa –ikpa	Flower, aerial part	Lignans arctigenin, trachelogenin.	35
26	Umbrelliferae	*Centella asiatica*	Gotu kola	Oba	Aerial part	Asiaticoside, Asiatic acid	22
27	Labiatae	*Melissa officinalis* L.	Lemon balm	Nchuanwunta, Nchuanwuofia	Leaf	Acetylcholine precursors	24,25
28	Papaveraceae	*Papaver somniferum* Vault	Opium poppy	Ubuluinu	Aerial part	Endogenous opiate receptors	26
29	Scrophulariaceae	*Bacopa monnieri* L.	Water hyssop	Ukwani	Aerial part	Saponin, triterpenoid, bacopaside, betulic acid, polyphenols	28, 29
30	Araceae	*Acorus calamus* L.	Sweet flag, Calamus	Ukara, Ezeogwu	Leaves	A and β asarone	17
31	Clusaceae	*Urtica dioica* L.	Common nettle	Akuwa	Aerial part	Boron	18
32	Combretaceae	*Terminalia chebula* Retz	Myrobalan fruit	Otin	Fruit	Acetylcholine-esterase (AChE) inhibitors	33
33	Lamiaceae	*Salvia miltiorrhizia*	Red sage	Imumu	Root, leaves	Cryptotanshinone	34
34	Vitaceae	*Vitis vinifera* L.	Grape	Oroma Okpo	Fruit	Fisetin, cyanidine	43, 44
35	Rutaceae	*Citrus sinensis* (L.) Osbeck	Orange	Oroma, Epe	Fruit	Glutathione	39
36	Musaceae	*Musa acuminate*	Banana	Unere	Fruit	Glutathione	39
37	Arecaceae	*Cocos nucifera* L	Coconut	Aki bekee	Fruit (oil, milk powder)	Medium chain triglycericles (MCT)	45
38	Pedaliaceae	*Sesame indicum* L.	Sesame	Agbala, Agbaloko	Seed	Sesaminol glycosides	45
39	Piperaceae	*Piper nigrum* L.	Black pepper	Uziza, nmimi	Fruit	Piperine, flavonoids	47
40	Clusiaceae	*Garcinia mangostana* L	Mangosteen	Akilu	Fruit	Xanthone gamma-mangostin	48, 49
41	Amaranthaceae	*Spinacia oleracea*	Spinach	Nahianwu	Leaves	Polyphenol, folate	50
42	Euphobiaceae	*Manihot esculenta*	Cassava	Jigbo	Leaves and roots	Folates, pyridoxine	53
43	Plantaginaceae	*Plantago majus*	Plantain	Jioko	Fruit	Glutathione	39
44	Anacardiaceae	*Anacardium*	Cashew	Cashu	Seed (nut)	Cardol,	57

		occidentale				cardonols,anacardic acid and methycardols	
45	Juglandaceae	*Juglans regia* L.	Walnut	Ukpa	Seed (nut)	α-linolenic acid (lant based omega-3 fatty acid), flavonoids and selenium.	58, 59 and 60

5. Discussion

The outcome of this inventory revealed that many herbal practitioners use different plant species as remedy for Alzheimer's disease and therefore the information about the phytochemical constituents and therapeutic value of the plant species vary. The survey shows that Fabaceae, Graminae, Amaryllidaceae and Laminaceae were families mostly used the treatment of Alzheimer's disease (Table 1). These plant families are among the ones mostly seen in Nigeria [20, 21]. The plants found in this survey are in line with the work of other researchers on plants used in the treatment of Alzheimer's disease. Such plants used in the treatment of Alzheimer's disease include *Glycine max* [22, 23], *Allium sativum* [24, 25], *Acorus calamus* [17], *Piper nigrum* [26], *Zingiber officinale*, *Allium cepa* [27], *Telfaria occidentalis* [28, 29], *Manihot esculenta* [30] and *Cymbopogon citratus* [31].

It can be depicted from this inventory that these plants contain some phytochemicals for the treatment of Alzheimer's disease though the knowledge of active chemical constituents and their mode of operation from this documentation is not exhaustive. Notable chemical and phytochemical works have been done on some of the plants investigated and include *Zingiber officinale* [32, 33], *Allium sativum* [34, 35], *Allium cepa* [36, 37], *Curcuma longa* [38, 39] and *Manihot esculenta* [39, 40]

The plants studied can be viewed as potential sources for active drugs and therefore should be explored for pharmaceutical and therapeutic purposes

6. Conclusion

Plants have been used over the years to treat different health challenges and difficulties. Several plants and their parts have been studied in this research to reveal their therapeutic potential in the treatment of Alzheimer's disease. The plants contain active chemical compounds such as cantharidin, fisetin, saponin, triterpenoid, bacopaside, betulic acid, polyphenols etc.They have been found to be effective as remedy for Alzheimer's disease and are used by health practisioners in south eastern Nigeria in the treatment of the disease. Some of the plants are fruits and vegetables and does not show any side effect when consumed for their health benefits. These plants can explored for vital drug production.

References

[1]   Fratiglioni, L. and Wang, H. X., 2000. "Smoking and Parkinson's and Alzheimer's disease review of the epidemiological studies." *Behav. Brain Res.,* vol. 113, pp. 117-120.

[2]   Singhai, A. K., Naithani, V., and Bangar, O. P., 2012. "Medical plants with potential to treat Alzheimer's and associated symptoms." *Int. J. Nutri Pharmacol. Neurol. Dis.,* vol. 2, pp. 84-91.

[3]   Zhang, L., Fiala, M., Cashman, J., Sayre, J., Espinosa, A., and Mahanian, M., 2006. "Cucurminoids enhance amyloid beta uptake by macrophages of Alzheimer's disease patients." *J. Alzheimer's Disease,* vol. 10, pp. 1-7.

[4]   Baptista, F. I., Henriques, A. G., Silva, A. M., and Wiltfang, J., 2014. "Flavonoids as therapeutic compounds targeting key proteins involved in Alzheimer's disease." *ACS. Chem. Neurosci.,* vol. 5, pp. 83-92.

[5]   Simpkins, J. W., Green, P. S., and Gridley, K. E., 1997. "Role of estrogen replacement therapy in memory enhancement and prevention of neuronal loss associated with Alzheimer's disease." *Brain Res.,* vol. 103, pp. 195-253.

[6]   Green, P. S. and Simpkins, J. W., 2000. "Estrogen and estrogen-like non-feminizing compounds. Their role, the prevention and treatment of Alzheimer's disease." *Ann. NY. Acad. Aci.,* vol. 924, pp. 93-98.

[7]   Alzheimer's Association, 2015. "Alzheimer' Disease facts and figures. Chicago." Available: www.alz.org

[8]   Fratiglioni, L., De Ronchi, D., and Aguero-Torres, H., 1999. "Worldwide prevalence and incidence of dementia." *Drug Aging,* vol. 15, pp. 365-375.

[9]   Rosler, M., Retz, W., Thome, J., and Riederer, P., 1998. "Free radicals in Alzheimer's dementia: currently available therapeutic strategies." *J. Neural. Transm.,* vol. 54, pp. 211-219.

[10]   Alzheimer's Association, 2009. "Alzheimer' disease facts and figures." Available: www.alz.org/national/documents/report

[11]   Celec, P., Ostatnikova, D., Caganova, M., Zuchova, S., Hodosy, J., and Putz, Z., 2005. "Endocrine and cognitive effects of short-time soybean consumption in women." *Gynecol Obstet Invest,* vol. 59, pp. 62-66.

[12]   Celec, P., Ostatnikova, D., Hodosy, J., Putz, Z., and Kudela, M., 2007. "Increased one week soybean consumption affects spatial abilities but not sex hormone status in men." *Int. J. Food Sci. Nutr.,* vol. 58, pp. 424-428.

[13]   Ostatnikova, D., Celec, P., Hodosy, J., Hampl, R., Putz, Z., and Kudela, M., 2007. "Short-term soybean intake and its effect on steroid sex hormones and cognitive abilities." *Fertil Steril,* vol. 88, pp. 1632-1636.

[14] Levites, Y., Amit, T., Mandel, S., and Youdim, M. B., 2003. "Neuroprotection and neurorescue against Abeta toxicity and PKC-dependent release of nonamyloidogenic soluble precursor protein by green tea polyphenol (-)-epigallocatechin-3 gallate." *J. Faseb.,* vol. 17, pp. 952-954.

[15] Bores, G. M., Huger, F. P., Petko, W., Mutlib, A. E., Camacho, F., and Rush, D. K., 1996. "Pharmacological evaluation of novel Alzheimer's disease therapeutics: Acetylcholinesterase inhiitors related to galanthamine." *J. Pharmacol. Exp. Ther.,* vol. 277, pp. 728-738.

[16] Ikay, O., Gurdal, O., and Bilge, S., 2010. "An update on plant originated treatment for Alzheimer's disease. Ethnomedicine: A source of complementary therapeutics." pp. 245-265.

[17] Cannert, H. and Hoyer, S., 1998. "Intracerebroventricular administration of streptozotocin causes long term dimunitions in learning and memory abilities and in cerebral energy metabolism in adult rats." *Behav. Neurosci.,* vol. 112, pp. 1199-1208.

[18] Keyvan, D., Damien, D. H. J., Heikki, V., and Raimo, H., 2007. "Plants as potential sources for drug development against Alzheimer's disease." *Int. J. Biomed. Pharm. Sci.,* vol. 1, pp. 83-104.

[19] Idu, M., Obayagbona, N. O., Oshomoh, E. O., and Erhabor, J. O., 2014. "Phytochemical and antimicrobial properties of Chrysophyllum albidum, Dacryodes edulis, Garcinia colachloroform and ethanolic root extracts." *J. Intercult. Ethnopharmacol,* vol. 3, pp. 15-20.

[20] Okunji, C. O. and Iwu, M. M. M. M., 1991. "Moluscidal activity of Garcinia kola biflavonones." *Fitoterapia,* vol. 67, pp. 74-76.

[21] Dhanasekaran, M., Holcomb, L. A., Hit, A. R., Tharakan, B., Porter, J. W., Young, K. A., and Manyam, B. V., 2009. "Centella asiatica extract selectively decreases amyloid beta levels in hippocampus of Alzheimer's disease animal model." *Phytother. Res.,* vol. 23, pp. 14-19.

[22] Habib, S., Afridi, K., Wasay, M., and Igbal, R., 2014. "Isoflavonees and Alzheimer's disease: the effects of Soy in diet." *Pakistan J. Neurological Science,* vol. 9, pp. 40-45.

[23] Williams, R. J. and Spencer, J. P., 2012. "Flavonoids, cognition and dementia: actions, mechanisms and potential therapeutic utility for Alzheimer's disease." *Free Radic. Biol. Med.,* vol. 52, pp. 35-45.

[24] Peng, Q., Buzzard, A. R., and Lau, B. H., 2002. "Neuroprotective effect of garlic compounds in amyloid – beta peptide- induced apoptosis in vitro." *Med. Sci. Monit.,* vol. 8, pp. 328-337.

[25] Chauhan, N. B., 2006. "Effect of aged garlic extract on APP processing and tau phosphorylation in Alzheimer's transgenic model Tg2576." *J. Ethnopharmacol,* vol. 108, pp. 385-394.

[26] Subedee, L., Suresh, R. N., Jayanthi, M. K., Kalabharathi, H. L., Satish, A. M., and Pushpa, V. H., 2015. "Preventive role of indian black pepper in animal models of Alzheimer's disease." *J. Clin. Diagn. Res.,* vol. 9, pp. 1-4.

[27] Oi, Y. M., Imafuku, C., Shishido, Y., Kominato, S., and Nishimura, K., 1999. "Allyl – containing sulphides in garlic increase uncoupling protein content in brown adipose tissue and noradrenaline and adrenaline secretion in rats." *J. Nutri.,* vol. 129, pp. 339-342.

[28] Burgess, J., Stevens, L., Zhang, W., and Peck, L., 2000. "Polyunsaturated fatty acids in children with attention- deficit hyperactivity disorder." *Am. J. Clin. Nutri.,* vol. 71, pp. 327-320.

[29] Cole, G. M., 2009. "Omega -3 fatty acids and dementia. Prostaglandins." *Leukot Essent Fatty Acids,* vol. 81, pp. 213-221.

[30] Zieliriski, E. L., 2013. "The amazing cassava root: Vegans tapioca recipe included." *Natural News,* Available: www.naturalnews.com/039378-cassava-root

[31] Chakravarthi, K. K. and Avadhani, R., 2013. "Beneficial effect of aqueous root extract of Glycyrrhiza glabra on learning and memory using different behavioural model: An experimental study." *J. Nat. Sci Biol. Med.,* vol. 4, pp. 420-425.

[32] Sekiwa, Y., Kubota, K., and Kobayashi, A., 2000. "Location of novel glycosides from ginger and their antioxidative activity." *J. Agric. Food Chem.,* vol. 8, pp. 373-379.

[33] Eleazu, C. O., Eleazu, K. C., Awa, E., and Chukwuma, S. C., 2012. "Comparative study of the phytochemical composition of the leaves of five Nigerian medicinal plants." *Journal of Biotechnology and Pharmaceutical Research,* vol. 3, pp. 42-46.

[34] Huzaifa, U., Labaran, I., Bello, A. B., and Olatunde, A., 2014. "Phytochemical screening of aqueous extract of garlic (Allium sativum) bulb." *Rep. Opinion,* vol. 6, pp. 1-4.

[35] Olusanmi, M. J. and Amadi, J. E., 2009. "Studies on the antimicrobial properties and phytochemical screening of garlic (Allium sativum) extract." *Ethnobotanical Leaflets,* vol. 13, pp. 1186-1196.

[36] Ugwoke, C. E. C. and Ezugwe, C. O., 2010. "Phytochemical screening and proximate composition of onion bulb (Allium cepa L.)." *Journal of Pharmaceutical and Allied Sciences,* vol. 7, Available: http://dx.doi.org/10.4314/jophas.v7i2.63396

[37] Lalitha, G., Sivaraj, R., Maheswari, S. U., and Nirmala, A., 2009. "Antimicrobial activity and preliminary phytochemical screening of Allium sativum and Citrus lemon." *Journal of Medicinal Food Plants,* vol. 1, p. 11.

[38] Rajesh, H., Rao, S. N., Megha, R. N., Prathima, K. S., Rejeesh, E. P., and Chandrashekar, R., 2013. "Phytochemical analysis of methanolic extract of Curcuma longa Linn Rhizome." *Inter. J. of Universal Pharmacy and Bio Sciences,* vol. 2, pp. 1-7.

[39] Mohammad, N. H., Aysha, F., Nargis, A., Shahnaz, R., Shahadat, H., and Mohammed, R., 2014. "Preliminary phytochemical screening, toxity, antihyperglycemic and analgesic activity studies with Curcuma longa leaves." *World Journal of Pharmacy and Pharmaceutical Sciences,* vol. 3, pp. 81-91.

[40]   Wobesto, C., Correa, A. D., De Abreu, C. M. P., Dos santos, C. D., and Pereira, H. V., 2007. "Antinutrients in the cassava leaf powder at three ages of the plant." *Cienic Technol. Aliment,* vol. 27, pp. 108-112.