

# Ethnobotanical Plants Used for Oral Healthcare Among the Esan Tribe of Edo State, Nigeria.

<sup>1</sup>Idu, M., <sup>2</sup>Umweni, A. A., <sup>1</sup>Odaro, T. and <sup>1</sup>Ojelede L.

<sup>1</sup>Department of Botany, University of Benin, PMB 1154, Benin City, Nigeria      <sup>2</sup>Department of Preventive Dentistry, University of Benin, PMB 1154, Benin City, Nigeria

Issued 01 April 2009

## Abstract

Ethnobotanical survey of plants used as chewing sticks for oral healthcare was conducted in Esan region, of Edo State Nigeria. In the course of this survey, 32 plant species belonging to 31 genera and 23 families was documented. It was observed that plants used by the locals are carefully selected for properties such as hardness, or bitterness and certain species were more popular than others. Some of these species had medicinal properties used for the treatment of malaria, stomach troubles, cough, diarrhea, dysentery, and tuberculosis. The oral health status of the locals, especially the youths and the middle aged are indications of the potential dental recipe, contained in some of these plant species.

**Key words:** Ethnobotanical, Oral Healthcare, Esan Tribe, Nigeria.

## Introduction

The long and venerable history of the use of plants to improve dental health and promote oral hygiene has been known since antiquity. Cuttings of root, stem or twigs of trees and shrubs have served as traditional toothbrush commonly called chewing sticks. Almas (2002) and Hyson (2003), reported that chewing sticks were in use from as early as some 7000 years ago by the Babylonians, and later throughout the Greek and Roman empires; it is also believed to be the precursor of the modern day toothbrush and was used in Europe about 300 years ago. In vast parts of the world where toothbrush is uncommon, this practice still persists especially among many African and Asian countries as well as in isolated areas of tropical America and throughout the Islamic countries (Lewis and Lewis, 1977; Yarde and Robinson, 1996; Hattab, 1997; Darout *et al.*, 2005).

Chewing sticks are important non-timber forest products (NTFP) widely used for dental cleaning in tropical West Africa (Akande and Hayashi, 1998). These sticks impart varying taste sensations; a

tingling peppery taste, bitter taste and numbness are provided (Bauda and Boakye- Yiadom, 1973). As it is chewed the frayed stick is used to clean the teeth, simultaneously removes plaque massages the gums. These advantages of the chewing stick over the conventional toothpaste and brush have been attributed to the strong teeth of Africans (Ugoji *et al.*, 2000).

Most people of Esan rural communities rely on plants for their primary healthcare needs, they go about their daily activities with sticks protruding from their mouths which they chew or use to scrub their teeth. These sticks they say provide not just dental hygiene but also cure variety of other ills. Human depended on plants for cure of most ailments until scientific advances introduced chemical synthesis (Isichei, 2005). Dependence on medicines derived from indigenous plants is especially predominant in developing countries; this creates the need for the development of traditional medicine to ensure safe and efficacious practices. The use of medicinal plants is an important part of traditional medicine in many cultures and is the basis of on-going efforts to develop new drugs in conventional medicine, and a common criticism of herbal medicine is the lack of properly designed clinical trials (Nartey *et al.*, 2007). An increasing reliance on the use of medicinal plants in the industrialized societies, have been traced to the extraction and development of several drugs and chemotherapeutics from these plants as well as from traditionally used herbal remedies (Idu and Onyibe, 2008), and as such plants have been incorporated into dentifrices and also the use of plants to provide natural chewing gums for oral hygiene, to treat toothache, gingivitis and periodontal disease, are several modern examples for this practice (Bone, 2005). As a result, traditional healers have put forward many claims about the healing power of the plant world, some of which have been investigated and substantiated scientifically (Idu *et al.*, 2006a). Furthermore, Robbers *et al.*, (1996) posited that, plant materials are present in, or have provided the models for more than 50% of the Western drugs, that is to say, many commercially proven drugs used in modern medicine were initially in crude form in traditional or folk healing practices or for other purposes that suggested potentially useful biological activities. Generally, drug plants are unique in containing compounds that are end products of biosynthetic pathways and are usually not needed in such plants' metabolic processes. In the field of ethnomedicine, it has been discovered that therapeutic efficacy was more pronounced when the active compound was left in a particular combination with other principles naturally present in plants, than when the active compound was isolated and synthesized in the laboratory. This indicates that the use of plants as an alternative tool for dental and oral hygiene is natural and may be more effective. In the study area, plant species used are selected to suit individual preference, with more species used because of their contained medicinal properties.

At present works on ethnobotanical uses of plants have been documented (Gill and Akinkumi,

1988; Gill, 1992; Idu and Olorunfemi, 2002; Ilondu and Okoegwale, 2002; Ndukwu and Obute, 2002; Idu and Omoruyi 2003; Idu *et al.*, 2003; Mirutse *et al.*, 2003; Harsha *et al.*, 2003; Idu *et al.*, 2005; Idu *et al.*, 2006b; Idu and Osemwegie, 2007; Idu *et al.*, 2007a; Idu and Onyibe, 2008), still vast store of ethnobotanical information with traditional knowledge is yet to comprehensively documented.

These indigenous practices of the use of plants in traditional medicine have come about by no more than the accumulation of knowledge by experiences, which are the basis of the folklore of plants possessed by many relatively underdeveloped indigenous tribes today, living with and using plants as part of their day to day existence. And there exists the danger that these knowledge and practices will rapidly disappear, through forgetfulness, coupled with urbanization, or conscious rejection of these knowledge and practices as not being modern or scientific. There is therefore an urgent need for these indigenous knowledge and practices to be documented, before they are eliminated.

In this paper, an attempt has been made to enumerate some plant species and their indigenous uses as chewing sticks for dental and oral healthcare, by the locals of some communities in Esan region of Edo State, Nigeria.

## **Materials and Methods**

The fieldwork was carried out in the month of November, 2007. The study area comprise of the following zones: Esan West, Igueben, Esan Central, Esan North East and Esan South East Local Government Areas (Figure 1). In each zone a few rural communities were selected in relationship to their geographical distribution. Direct interaction with local respondents was adopted to get information about the variety of species used as chewing sticks. Herbarium specimens of plant species described were pressed, dried and mounted, and then identified with the aid of taxonomic literatures (Keay, 1989; Gill, 1992; Akobundu and Agyakwa, 1998)

Ethnobotanical information was collected using direct interviews and discussions with local people. The informants were carefully selected to represent both male and female, youth and middle aged. The attributing of local names to the plants to some extent establishes some sort of relationship between people and plants and shows that the people are quite familiar with them. Local names of plants may vary from one community to another, in some cases more than one name could refer to a particular plant. The plants having traditional knowledge of utilization among the people of a particular community have been selected as reference specimens and have been checked from other sites visited.

In the following enumerations, the plant species used as chewing sticks for oral hygiene, are listed in alphabetical order.

## Results and Discussion

*Alchornea cordifolia* (Schum. & Thonn.) Mull.Arg.

- Family name:** Euphorbiaceae
- Local name:** Akowo, uwanwe
- Part used:** Twig, root
- Folk use:** Chewed for toothache and teeth cleaning.

*Allophylus africanus* P. Beauv

- Family name:** Sapindaceae
- Local name:** Ebe, ukpe
- Part used:** Twig, root
- Folk use:** Chewed for teeth cleaning, toothache and diarrhoea.

*Anacardium occidentale* Linn

- Family:** Anacardiaceae
- Local name:** Ikashu
- Part used:** Twig
- Folk use:** Chewed for sore gum and teeth cleaning.

*Aulococalyx jasminiflora* Hook. F.

- Family name:** Rubiaceae
- Local name:** Amegben
- Part used:** Twig
- Folk use:** Chewed for teeth cleaning.

*Azardirachta indica* A. Juss.

**Family name:** Meliaceae  
**Local name:** Dongoyaro.  
**Part used:** Twig, stem bark  
**Folk use:** Chewed for malaria, stomach-ache, sore throat, teeth cleaning.

*Baphia nitidia* Lodd.

**Family name:** Fabaceae  
**Local name:** Otua  
**Part used:** Twig, stem  
**Folk use:** Chewed for teeth cleaning.

*Carpolobia lutea* G. Don.

**Family name:** Pologalaceae  
**Local name:** Aswen  
**Part used:** Twig, stem  
**Folk use:** Chewed for stomach-ache and teeth cleaning.

*Caseari barteri* Mast.

**Family name:** Flacourtiaceae  
**Local name:** Ukpakuzon, akpano-eze  
**Part used:** Twigs, stem bark  
**Folk use:** Chewed for sore gum and teeth cleaning.

*Citrus aurantifolia* (Christm.) Swingle.

**Family name:** Rutaceae

**Local name:** Anumei- negwegwe  
**Part used:** Twig, stem  
**Folk use:** Chewed for vomiting, toothache and teeth cleaning.

*Citrus sinensis* (Linn.) Osbeck.

**Family name:** Rutaceae  
**Local name:** Anumei  
**Part used:** Twig, stem  
**Folk use:** Chewed for vomiting, toothache and teeth cleaning.

*Dennettia tripetala* Bak. F.

**Family name:** Annonaceae  
**Local name:** Ukpakon okhan, ohure, ako  
**Part used:** Twig  
**Folk use:** Chewed for toothache and teeth cleaning.

*Dialium guineense* Willd.

**Family name:** Fabaceae  
**Local name:** Ohiome  
**Part used:** Twig, bark  
**Folk use:** Chewed for stomachache and teeth cleaning.

*Diospyros barteri* Hiern.

**Family name:** Ebenaceae  
**Local name:** Elugbe, ivin-oha  
**Part used:** Twig

**Folk use:** Chewed for teeth cleaning.

*Garcinia kola* Heckel.

**Family name:** Clusiaceae

**Local name:** Edun

**Part used:** Twig

**Folk use:** Chewed for teeth cleaning.

*Glyphea brevis* (Spreng.) Mona.

**Family name:** Tiliaceae

**Local name:** Uwenriotan, aghemhen

**Part used:** Twig, stem bark

**Folk use:** Chewed for diarrhea, fever and teeth cleaning.

*Irvingia gabonensis* (O'Rorke) Baill.

**Family name:** Irvingiaceae

**Local name:** Ohiele, ogwe (ogbono)

**Part used:** Stem

**Folk use:** Chewed for teeth cleaning.

*Measobotrya barteri* (Baill.) Hutch.

**Family name:** Euphorbiaceae

**Local name:** Orua, Oruru

**Part used:** Twig

**Folk use:** Chewed for waist pain and teeth cleaning.

*Mallotus oppositifolia* (Geisel) Mull. Arg

**Family name:** Euphorbiaceae  
**Local name:** Ogheghe  
**Part used:** Twig  
**Folk use:** Chewed for oral hygiene and teeth cleaning.

*Microdesmis puberula* Hook. F. ex Planch.

**Family name:** Pandaceae  
**Local name:** Amama, erankpata  
**Part used:** Twig  
**Folk use:** Chewed for sore gum and teeth cleaning especially for elders.

*Napoleonaea imperialis* P. Beauv.

**Family name:** Lecythidaceae  
**Local name:** Ukpakon risa  
**Part used:** Twig  
**Folk use:** Chewed for cough and teeth cleaning.

*Nesogardonia papaverifera* (A. Chev.) R. Capuron.

**Family name:** Sterculiaceae  
**Local name:** Urhuaro.  
**Part used:** Twig  
**Folk use:** Chewed for oral hygiene and teeth cleaning.

*Newbouldia leavis* (P. Beauv.) Seamon ex Bureau

**Family name:** Bignoniaceae  
**Local name:** Ikhimi



**Part used:** Twig, stem bark

**Folk use:** Chewed for toothache, oral hygiene and teeth cleaning.

*Ocimum basilicum* Linn.

**Family name:** Lamiaceae

**Local name:** Alumonkho

**Part used:** Twig

**Folk use:** Chewed for oral hygiene, headache, cough and stomachache

*Paullinia pinnata* Linn.

**Family name:** Sapindaceae

**Local name:** Aza, eka

**Part used:** Root

**Folk use:** Chewed for diarrhoea and teeth cleaning.

*Pentaclethra macrophylla* Benth.

**Family name:** Fabaceae

**Local name:** Okpagma

**Part used:** Stem bark

**Folk use:** Chewed for stomachache, appetizer, teeth cleaning and weakness.

*Piper guineense* Schum. & Thonn.

**Family name:** Piperaceae

**Local name:** Akboko

**Part used:** Root

**Folk use:** Chewed for oral hygiene and stomachache.

*Psidium guajava* Linn.

**Family name:** Myrtaceae  
**Local name:** Gova  
**Part used:** Twig  
**Folk use:** Chewed for toothache and oral hygiene.

*Sida acuta* Burm. F.

**Family name:** Malvaceae  
**Local name:** Alebha  
**Part used:** Twig, stem  
**Folk use:** Chewed for toothache, sore gum and teeth cleaning

*Sorindeia mildbraedii* Engl. & V. Brehm.

**Family name:** Anacardiaceae  
**Local name:** Ehegogo  
**Part used:** Twig, bark  
**Folk use:** Chewed for oral hygiene.

*Spondias mombin* Linn.

**Family name:** Anacardiaceae  
**Local name:** Okhigha  
**Part used:** Twig, bark  
**Folk use:** Chewed for sore throat and oral hygiene.

*Vernonia amygdalina* Del.

**Family name:** Asteraceae

**Local name:** Oriwo

**Part used:** Root, twig

**Folk use:** Chewed for toothache, stomachache, gingivitis and teeth cleaning.

*Zanthoxylum zanthoxyloides* (Lam.) Zap. & Tim. in Denovia.

**Family name:** Rutaceae

**Local name:** Ukhiaghele, ughanhan

**Part used:** Root bark

**Folk use:** Chewed for cough tuberculosis and teeth cleaning.

Oral health is part of total health and essential to quality of life. This is to say that an unhealthy condition of the mouth and teeth can affect all parts of the body producing much ill health. Bone (2005) posited that systematic health maybe more affected by oral hygiene than previously recognized. In this review, he discussed possible etiological associations between periodontitis and cardiovascular disease in general, and endocarditis specifically, as well as rheumatoid arthritis, pneumonia, pre-term birth and low birth weight.

Periodontal inflammation, which facilitates the entrance of bacteria into the blood stream especially after chewing food or cleaning the teeth, (either by direct effect from the bacteria or from the inflammation which their presence may trigger) could lead to thrombus formation and/or the development of atherosclerotic lesions. The research which supports role for a few key plants showed that chewing sticks had significantly lower dental calculus, lower signs of periodontal disease and a tendency to reduce gingival bleeding than tooth brush users.

Furthermore, in a study that compared the effect of chewing stick or toothbrush using on plaque removal and dental health, chewing stick resulted in significant reductions in plaque. And another study which compared the levels of 25 oral bacteria in chewing stick and toothbrush users showed that certain bacteria especially several oral streptococci species were lower among the chewing stick users. However, chewing stick was associated with greater gum recession (Bone, 2005). Other studies carried out to assess the efficacy of chewing sticks, have also given favourable results asserting that chewing sticks are suitable for dental and oral healthcare (Enwonwu, 1974; Sofowora, 1982; Rotimi *et al.*, 1988; Ndugu *et al.*, 1990; Gazi *et al.*, 1990; Hattab, 1997; Kassu, 1997; Ugoji *et al.*, 2000; Almas, 2002; Adekunle and Odukoya, 2006; Idu *et al.*, 2007b).

The World Health Organization (WHO) puts oral disease among the top five causes of burden in 'lost healthy years' worldwide (WHO 2004). The commonest dental disease is periodontal diseases that are mainly as a result of poor oral hygiene. Periodontal diseases are any pathological processes affecting the periodontal tissues which include the gums, bone and the ligaments holding the teeth to the bone. It is essentially caused by bacterial plaque accumulation around the neck of the teeth and it affects all humans without regard for race or gender. Bacterial plaque and their products, especially enzymes and endotoxins initiate the inflammatory process of the diseases.

The next common dental disease is dental caries caused by a combination of taking surgical substance, bacterial plaque and susceptible tooth surface and it is the main cause of loss of teeth in younger people. The teeth due to its function should be cleaned at least twice a day after meal to remove any particle of food lodged between the teeth, a good flow of saliva helps also in the removal of these food particles, but this flow is highly reduced at night and also during mouth breathing, it is therefore necessary that the teeth be cleaned before retiring. If food remains it is decomposed by bacteria, these bacteria acts on it producing acids, the acids produced destroy the enamel and expose the dentine to the action of the bacteria, allowing them to penetrate the pulp cavity causing pain, when the pulp cavity are irritated, toothache develops, and a decaying tooth may cause all kinds of disorders including rheumatism, lumbago and indigestion. This is in line with the research by Bone (2005).

The primary function of the teeth is the mastication of food; in this the movement of the tongue and cheek muscles aids them. And in order that they should develop correctly and remain in an efficient and healthy condition these structures must have sufficient work to do, for no tissue or organ will maintain its strength and efficiency if it is not exercised. With the modern methods of refining raw materials and softening of food by various processes of cooking, the necessity for vigorous muscular action no longer exists, and the stimulating effect of such action is lost. Especially in the civilized race, the lower part of the face has been reduced in size, but the teeth have not changed in a corresponding manner, with the result that people have teeth which are not in harmony with the size of other features, and have not the room to develop correctly. Therefore, chewing sticks provides this mechanical feature, which stimulates the growth of the jaw; exercise of the jaw; and the hardening of the teeth. This supports the report by Ugoji *et al.*, (2000)

The information and results of the study leads to the following conclusions:

- The plant-use in the study area is essentially subsistence-oriented and it needs modern and scientific approach for sustainable development.

- The people of the study area have inherited a certain sense of conservation, but the demand and exploitation of plant resources is inversely proportional to the conservation and regeneration efforts.
- For the economic uplift and improvement in quality of life, an organized plant-use strategy is to be developed. If their resources are pooled together and harnessed properly, the people of these rural communities can come up with a standard of preserving their cultures and traditions.

The survey of ethnobotanical plants used for dental and oral healthcare therefore brings to light some aspects of plant utilization among the Esan of Edo State Central Nigeria, and the traditional toothbrush or chewing stick is a major means of keeping oral hygiene in these rural communities, as such the use of chewing sticks is widely considered a symbol of personal hygiene. The present trend of development of these communities also indicate that in spite of the establishment of a few modern health centres, the use of plants and traditional practices will continue to play a significant role in the socio-cultural life of these communities. The possession of a protracted span of memory in form of language are other characteristics peculiar to man which makes it possible to create and transmit culture, and it should be remarked that culture is not a static thing, it is an active process, it accumulates and becomes diffused, through increasing contact with other societies, therefore the culture of any society changes. Prior to the loss of indigenous species and elimination of traditional knowledge, efforts should be made to document useful plant species and vast store of indigenous ethnobotanical knowledge and practices, and also the development of traditional medicine to ensure safe and efficacious use of ethnobotanical plants in phytomedicine.

## References

- Adekunle, A. A. and Odukoya, K.A. (2006). Antifungal Activities of Ethanol and Aqueous Crude Extracts of Four Nigerian Chewing Sticks. *Ethnobotanical Leaflets*, <http://ww.siu/-ebl/leaflets>.
- Akande, J. A. and Hayashi, Y. (1998). Potency of extract contents from selected tropical chewing sticks against *Staphylococcus aureus* and *Staphylococcus auricularis*. *World Journal of Microbiology and Biotechnology*, **14**: 235-238.
- Akobundu, J. A. and Agyakwa, C. W. (1998). A Handbook on West African Weeds. IITA: Ibadan. 420p.
- Almas, K. (2002). The effects of *Salvadora persica* extract (miswak) and chlorahexidine gluconate on human dentine. *The Journal of Contemporary Dental Practice*, **3**: 3.
- Bauda, C. V. and Boakye-Yiadom, K. (1973). The antibacterial activity of some Ghanaian chewing sticks. *Ghana Pharmaceutical Journal*, **1**: 150-151.
- Bone, K. (2005). Phytotherapy for periodontal disease and improved oral hygiene. *Townsend*

*letter for Doctors and Patients*. June 2005.

Darout, I. A., Astrom, A. N. and Skaug, N. (2005). Knowledge and behaviour related to oral health among secondary school students in Khartoum Province, Sudan. *International Dentistry Journal*, **55**: 224-230.

Enwonwu, C. O. (1974). Socio-economic factors in the dental caries prevalence and frequency. *Nigerian Caries Research*, **8**: 155-177.

Gazi, M., Saini, T., Ashri, N. and Lambourne, A. (1990). Miswak chewing stick versus conventional toothbrush as an oral hygiene aid. *Clinical Prevention Dentistry*, **12**: 19-23.

Gill, L. S. (1992). *Ethnomedicinal Uses of Plants in Nigeria*. Uniben Press, Benin City, Nigeria. 276p.

Gill, L. S. and Akinkumi, C. (1988). Nigerian folk medicine, practices and beliefs of Ondo people. *Journal of Ethnopharmacology*, **18**: 257-266.

Harsha, V. H., Hebbar, S. S., Shripathi, V. and Hedge, G. H. (2003). Ethnomedicinal Botany of Utlara Kannada district in Karnataka, India. Plants in treatment of skin disease. *Journal of Ethnopharmacology*, **48**: 37-40.

Hattab, F. N. (1997). Miswak: The natural toothbrush. *Journal of Clinical Dentistry*, **8**: 125-129.

Hyson, J. M. (2003). History of the toothbrush. *Journal of Historical Dentistry*, **52**: 73-80.

Idu, M. and Olorunfemi, D.I. (2002). Plants used for medicinal purposes by the Koma people of Adamawa State, Nigeria. *Indigenous Knowledge and Monitor*, **8**: 19.

Idu, M. and Omoruyi, M. (2003). Some ethnomedicinal plants of Higgi tribe from Adamawa State, Nigeria. *Ethnobotany*, **15**: 48-50.

Idu, M., Akinnibosun, H. and Omonhinmin, C.A. (2003). Ethnomedicinal field study in the wetlands of Udu and Ughievwen clans of Delta State, Nigeria. *Proceedings of Global Summit on Medicinal Plants*, **1**: 98-106.

Idu, M., Osawaru, M. and Orhue, E. (2005). Medicinal plants in some local markets in Benin City, Nigeria. *Ethnobotany*, **17**: 18-22.

Idu, M., Osemwegie, O.O. and Akinnibosun, H.A. (2006a). Floristic diversity of Okomu forest reserve in Southern Nigeria. *Phytotaxonomy*, **6**:14-22.

Idu, M., Omogbai, E.K.I., Amaechina, F. and Ataman, J.E. (2006b). Some cardiovascular effects of aqueous extracts of leaves of *Stachytarpheta jamaicensis* (Linn.) Vahl. *International Journal of Pharmacology*, **2**:163-165.

Idu, M. and Osemwegie, O.O. (2007). Some medicinal flora of Okomu Forest Reserve in Southern Nigeria. *Research Journal of Medicinal Plants*, **1**: 29-31.

Idu, M., Ndukwu, B.C. and Osemwegie, O.O. (2007a). Ethnofloristic study of Ethiope Council

Area of Delta State, Nigeria. *Journal of Plants Sciences*, **2**: 1-13.

Idu, M., Omogbai, E.K.I., Aghimien, G.C., Amaechina, F., Timothy, O. and Omonigho, S.E. (2007b). Preliminary phytochemistry and antimicrobial properties of *Stachytarpheta jamaicensis* (Linn.) Vahl. *Research Journal of Medicinal Plants*, **1**: 149-153.

Idu, M. and Onyibe, H.I. (2008). Medicinal plants of Edo State, Nigeria. *Research Journal of Medicinal Plants*, **1**: 32-41.

Ilondu, E.M. and Okoegwale, E.I. (2002). Some medicinal plants used in the management of dermatophytic diseases in Nigeria. *Journal of Environmental Studies*, **2**: 146-151.

Isichei, A.O. (2005). The role of plant resources in Nigeria's economic recovery agenda. *Nigerian Journal of Botany*, **18**: 1-22.

Kassu, A., Dagne, E., Abate D. and VanWyk, B.E. (1999). Ethnobotanical aspects of the commonly used toothbrush stick in Ethiopia. *East African Medical Journal*, **76**: 651-653.

Keay, R.W.J. (1989). Trees of Nigeria. Second Edition, Oxford Science Publisher, London. 476p.

Lewis, W.W. and Lewis, M.E. (1977). Medical Botany. Wiley Inter Science Publication, London.

Mirutse, G., Zemedu, A., Thomas, E. and Zerihum, W. (2003). An Ethnobotanical study of plants used by the Zay people in Ethiopia. *Journal of Ethnopharmacology*, **85**: 43-51.

Nartey, L., Huwiler-Muentemer, K., Shang, A., Liewald, K., Jueni, P. and Egger, M. (2007). Matched-paired study showed higher quality of placebo-controlled trials in Western Phytotherapy than conventional medicine. *Journal of Clinical Epidemiology*, **60**: 787-794.

Ndugu, F.L., Kaimenyi, J.T., Arneberg, P. and Muthami, L.N. (1990). A comparative study of the efficacy of plague control by a chewing stick and a toothbrush. *East African Medical Journal*, **67**: 907-911.

Ndukwu, B.C. and Obute, G.C. (2002). Cuticular features and delimitation of some members of Cucurbitaceae in parts of Southern Nigeria. *Nigerian Journal of Botany*, **18**: 98-106.

Robbers, J.M., Speedie and Tyler, V. (1996). Pharmacognosy and Pharmacobiotechnology. Williams and Wilkins, Baltimore, Pp 1-14.

Rotimi, V.O., Laughon, B.E., Bartlatt, J.G. and Masodomi, H.A. (1988). Activities of Nigerian chewing stick extracts against *Bacteriodes gingivalis* and *Bacteroides melaninogenicus*. *Antimicrobial agents and Chemotherapy*, **32**: 598-600.

Sofowora, E.A. (1982). Medicinal plants and traditional medicine in Africa. John Wiley and Sons Limited, Chiches. 404p.

Ugoji, E., Egwari, L.O. and Obisesan, B. (2000). Antibacterial activities of aqueous extracts of ten African chewing sticks on oral pathogens. *Nigerian Journal of Internal Medicine*, **3**: 7-11.

World Health Organization (WHO), (2004). The world health report, 2004, Geneva.

Yarde, A. and Robinson, M. (1996). The miswak chewing sticks: a traditional oral hygiene aid. *National Dental Association Journal*, 47: 20-21.