

Antimicrobial Potentials of Yaji-Spices: The Constituents of a Complex Nigerian Suya Meat Sauce Inducing Histological Investigations

A Nwaopara, C Anibeze, F Akpuaka, S Nwaopara

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Abstract

Spices and herbs have been used for thousands of centuries as preservatives for foods and for medicinal purposes. Some of these spices and herbs possess antimicrobial potentials that may, in combination, be considered as alternatives to conventional antimicrobial agents especially in this era of antimicrobial drug resistance. Our interest however, is on the widely consumed Nigerian suya meat sauce called Yaji. It is a complex mixture of salt, ginger, clove, red pepper and black pepper, all of which, on individual basis, have established antimicrobial properties. This paper therefore highlights these all-in-one antimicrobial potentials of Yaji.

INTRODUCTION

Despite the presence of biologically active substances, which, at high levels of consumption, can exhibit toxicity [1], spices have been included amongst the substances classified as nutrients and nutraceuticals [2]. In fact, it has been stated that tradition attaches all manner of benefit to every spice, condiment and herb as exemplified in the pharmacopoeias of Indian system of medicine including Ayurvedic, Sidha and Unani systems [3,4,5,6].

Worthy of note also is the fact that the 'science of nutrition' has been identified as a significant part of preventive medicine [7] and dietary regulations is an important component of the treatment of diabetes mellitus [8,9,10,11], atherosclerosis [12,13], constipation [14,15,16,17] and other ailment associated with overweight [18,19] and cancer [20,21,22]. Indeed, researchers believe that with diligent efforts, herbs (and spices) can be utilized for the utmost advantage to humans [23,24] and one such advantage, is their use as antimicrobial agents.

Antimicrobial agents are those substances or drugs with antifungal, antiviral, antiparasitic and antibiotic properties. According to the World Health Organization [25] antimicrobial agents have substantially reduced the threat posed by infectious diseases since their discovery in the 20th century. The use of these "wonder drugs", combined with

improvements in sanitation, housing, and nutrition, and the advent of widespread immunization programmes, has led to a dramatic drop in deaths from diseases that were previously widespread, untreatable, and frequently fatal. Over the years, such agents have saved the lives and eased the suffering of millions of people and have helped in bringing many serious infectious diseases under control. These drugs have also contributed to the major gains in life expectancy experienced during the latter part of the last century.

However, these gains are now seriously jeopardized by another recent development: the emergence and spread of microbes that are resistant to cheap and effective first-choice, or "first-line" drugs. As a result of this, it has been advised that the usage of antimicrobial agents by individuals is preferable when prescribed by a qualified physician since an overuse (or under-use), can propagate resistant microbial variants [26,27,28] and antimicrobial resistance is resulting in increased morbidity, mortality, and health-care costs [29].

Interestingly, scientific experiments since the late 19th century, have documented the antimicrobial properties of some spices, herbs and their components [30,31,32,33,34]. The interest in the use of compounds derived from spices as antimicrobial agents was sparked up by the changes in consumer attitudes towards the use of preservative agents such as nitrates and sodium chloride (NaCl) in foods during

in 1980s [31].

In this paper therefore, we highlight the antimicrobial potentials of the spices-in-combination within Yaji (a complex Nigerian meat sauce), since antimicrobial drug alternatives are becoming inevitable especially now that antimicrobial drug-dosage-compliant problems as well as 'self medication' is inducing microbial resistance against conventional antimicrobial agents.

Yaji is a complex mixture of groundnut powder, additives, spices and salt [35,36]. The spices in Yaji are ginger, cloves, red pepper, and black pepper, while the common additive other than salt, is Maggi [37]. Historically, the name 'Yaji' was an adaptation of the name of a 14th century Hausa ruler called "Yaji (meaning the 'hot one')" [38].

Yaji is a sauce for the meat delicacy called Suya; a boneless lean meat of mutton; beef or goat meat staked on sticks, coated with its sauce, oiled and then roasted around a burning fire [36]. According to Igene and Mohammed [39], Suya as a popular, traditionally processed, ready to eat Nigerian meat product, that may be served or sold along streets, in club houses, at picnics, parties, restaurants and within institutions. Omojola et al. [40] adds that Suya is one of such intermediate moisture product that is easy to prepare and highly relished while Uzeh et al. [41] described Suya as a mass consumer fast food whose preparation and sales along streets are usually not done under strict hygienic condition because they are still done locally.

Considering its mass-consumption rate and complexity, Yaji has become the basis for several histological investigations with interesting findings [37,42,43,44]. These investigations were aimed at determining the effect of excessive consumption of Yaji (or its constituent spices) on the Pancreas [37], Liver [42], Kidney [43] and the Heart [44]. Available results show that an excessive consumption of Yaji-spices especially in combination, is capable of inducing Pancreatic, Liver and Kidney tissue damage [37,42,43] but with no significant effect on the histology of the Heart under the same experimental conditions [44]. However, one other aspect of the ongoing investigation on Yaji is the non-experimental but analytical review of the potentials of Yaji that might be of public health concern; especially when one considers the large consumption population. Such is the report on the potential health hazards of Yaji by Nwaopara et al [45].

Judging from the histological findings above, one might conclude that the consumption of Yaji is always likely to produce a negative effect, which however, should not be the case, because the emphasis in the experiments was on the effect of an excessive consumption. In fact, we are convinced that a moderated consumption of Yaji has the potential to produce positive results in some sense and such can be seen in its antimicrobial potentials; considering the available information on the antimicrobial properties of its constituent spices.

THE ANTIMICROBIAL POTENTIALS OF

Some plant products can be considered to be natural sauces of antimicrobial agent as researchers from Ohio Wesleyan University have reported that some birds select nesting material rich in antimicrobial agents and this was believed to protect their young from harmful bacteria [46]. There is also a report that lowland gorillas take 90% of their diet from the fruits of *Aframomum melegueta*, a relative of the ginger plant, which is a potent antimicrobial and apparently keeps Shigellosis and similar infections at bay [47]. Indeed, it has been shown that sick animals tend to forage plants rich in secondary metabolites, such as tannins and alkaloids [48] and these phytochemicals often have antiviral, antibacterial, antifungal and antihelminthic properties [47]. It has also been observed that higher levels of spices are necessary to inhibit microbial growth in food than in the culture media [31].

This reminds one about the letter dated 9th October 1676, in which Van Leeuwenhoek described the decline in the number and activity of "animalcules" in a sample of well water following the addition of pepper [49]. In 1996, Cichewicz and Thorpe [50] performed a survey of the Mayan herbal pharmacopoeia and found a number of herbal remedies directed at ailments probably of microbial origin. Most of the remedies list capsicum fruit, alone or in conjunction with the leaves, roots, or seeds as the main ingredient and these were applied to a variety of ailments including respiratory problems, bowel complaint, earaches and sores [50].

There is a report that ginger has strong antibacterial and to some extent antifungal properties [51]. In vitro studies have shown that active constituents of ginger inhibit multiplication of colon bacteria [51]. Ginger inhibits the growth of *Escherichia coli*, *Proteus sp*, *Staphylococci*, *Strepto-cocci* and *Salmonella* [52,53,54,55]. Hence, ginger should have impact on the growth of *Bacillus cereus*, which

mainly causes diarrhoea and nausea [54,55].

Ginger extract and its pungent compounds demonstrated greater antibacterial activity against a variety of bacteria species including *Helicobacter pylori*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*, although mixed result is attributed to different ginger preparations and varying strength [56]. Such an extract of ginger has antimicrobial action at levels equivalent to 2000 mg/ml of the spice [51]. In addition, ginger inhibits *Aspergillus*, a fungus known for production of aflatoxin, a carcinogen [57,58]. Fresh ginger juice showed inhibitory action against *A.niger*, *S.cerevisiae*, *Mycoderma SPP* and *L. acidophilus* at 4, 10, 12 and 14% respectively at ambient temperatures [59].

The antimicrobial effect of clove is attributed to eugenol, which is the major active constituent of its essential oil [60]. The microbial inhibition of eugenol might be related to the membrane disruption or, according to Wendakoon and Sakaguchi [61], by inactivation of enzymes and genetic materials. The bactericidal activity of clove against food borne pathogens, like *Listeria monocytogenes* was reported in TSB by Ting and Deibel [62] and in saline solution by Aureli et al. [63]. The results presented by Smith-Palmer et al. [64] established that the essential oil of clove retained their low bacteriostatic and bactericidal concentrations even at 40C. Stecchini et al. [65], suggested a marked reduction in the number of *Aeromonas hydrophila* in meat samples treated with clove oil. Clove extract at 2000Ngml-1 showed bactericidal activity towards *Yersinia enterocolitica* in TSB [66].

It has been suggested that the cytoplasmic membrane is also target for eugenol action and results evidencing the K⁺ efflux corroborated this hypothesis. This result was in agreement with Degre and Sylvestre [67] who considered that the probable antimicrobial activity of eugenol was on cellular lipids resulting in the loss of intracellular contents.

Capsicum baccatum, *Capsicum chinense*, *Capsicum frutescens* and *Capsicum pubescens* varieties were tested for their antimicrobial effects with fifteen bacterial species and one yeast specie [50]. Two pungent compounds found in *Capsicum* species (Capsaicin and Dihydrocapsaicin) were also tested for their antimicrobial effects [50]. The plain and heated extracts were found to exhibit varying degrees of inhibition against *Bacillus cereus*, *Bacillus subtilis* *Clostridium sporogenes*, *Clostridium tetani*, and

Streptococcus pyogenes [50].

Capsicum extracts were shown to be growth-inhibitory on three of the sixteen microbial species tested. *Clostridium* species are common anaerobic bacteria often found in soil, sewage, aquatic sediments and decaying organic matter, as well as in the intestines of animals [68]. *Clostridium tetani* is the bacterium responsible for Tetanus and *Clostridium botulinum* (not tested) causes Botulism. *Streptococcus pyogenes* is the central pathogen identified in a variety of cutaneous and systemic infections. Thus, capsicum extracts do appear to have some valuable antimicrobial activity [68]. In fact, a later study has shown that Capsaicin strongly inhibits the growth of *Bacillus subtilis* [69] as aqueous and ethanolic extracts of black pepper have been screened for antibacterial activities against Penicillin G resistant strain of *Staphylococcus aureus* [70], *Bacillus cereus* and *Bacillus subtilis* [71].

Adebesin et al. [72] had observed in their study comparing the microbial counts of several peanut products, that there was a lower microbial count in Yaji, which they attributed to the antimicrobial potentials of its constituent spices. Of course available evidence supports the fact that spices inhibit microbial growth [30,33,34]. Again, the result of histological study conducted by Nwaopara et al. [43] on the Kidney showed the presence of round basophilic bodies in the interstitium of the kidney of rabbits following an excessive ingestion of Yaji spices. The argument was that in as much as the existing scientific evidence suggests that the presence of basophilic inclusion bodies in the kidney can be associated with microorganisms as reported in birds by Bernier et al. [73] and in humans by Nিকেleit et al. [74,75] and Drachenberg et al. [76], there was an obvious probability that the distinct round basophilic bodies in the interstitium of the renal cortex of the kidney as observed in the experiment, might not be micro - organism – related considering the overwhelming evidence about the antimicrobial potential of the constituent spices in Yaji [52,53,57,58,59,77,78,79,80,81,82].

CONCLUSION

Based on the forgoing therefore, the possibility of Yaji becoming an antimicrobial agent is not in doubt considering the barrage of information that are available to substantiate the antimicrobial potentials of its spice-constituents. In fact, the issues of dosage compliance and drug resistance, as well as the 'faking of spices' as compared to the 'faking of conventional antimicrobials' are significantly ruled out.

Moreover, spices are readily available, cheap, and durable; and a regular intake can as well serve as a preventive measure. However, the moderation of Yaji consumption is preferable and safer.

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CORRESPONDENCE TO

Anthony Obioma Nwaopara Department of Anatomy,
Ambrose Alli University, P. M. B. 14 Ekpoma, Edo State,
Nigeria. GSM: +234 803 744 1401 E-mail:
nwaoparaao@yahoo.com

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Author Information

Anthony Nwaopara, M.Sc.

Department of Anatomy, Ambrose Alli University

Chilie Anibeze, Ph.D.

Department of Anatomy, Abia State University

Francis Akpuaka, (FRCS (Ed), FRCS. (Glas.), FICS, FWACS)

Department of Anatomy, Abia State University

Sharon Nwaopara, BMLS

Department of Medical Laboratory Sciences, Ambrose Alli University