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REVIEW PAPER

ANTI-OXIDANT POTENTIALS OF *YAJI* SPICES

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ABSTRACT

Globally, spices have been used as coloring, flavoring and therapeutic agents, as well as food additives and preservatives, due to their anti-microbial, anti-parasitic, anti-helmintic and anti-oxidant potentials. Common amongst these spices are ginger, clove, red pepper and black pepper, which in combination, constitutes the main spices in *Yaji* –a complex Nigerian *Suya*-meat sauce that also contain groundnut cake flour, Ajinomoto (monosodium glutamate) and salt. Based on the clinical relevance of antioxidants and the growing concern on *Yaji* as regards its rate of consumption, hepatotoxicity, neurotoxicity and nephro- toxicity effect, this paper highlights the anti-oxidant potentials of ginger, clove, red pepper and black pepper –herein referred to as *Yaji* -spices.

Key Words: spices, anti-oxidants, medicine, flavoring agents.

INTRODUCTION

An anti-oxidant is an enzyme or other organic molecules that reduce the rate of particular oxidation reaction and can counteract the damaging effect of oxidation which can produce free radicals (Percival, 1998). They work by removing free radical intermediates and inhibiting other oxidation reactions by being oxidized themselves (Hamid et al., 2010). As a result, anti-oxidants are often reducing agents such as thiols or polyphenols (Bjelakovic, 2007).

Anti-oxidants are classified into two broad divisions, depending on whether they are soluble in water (hydrophilic) or in lipids (hydrophobic) (Gutierrez, 2011). In general, water soluble anti-oxidants react with oxidants in the cell cytoplasm and the blood plasma, while lipid-soluble anti-oxidants protect cell membrane from lipid peroxidation (Sies, 1997). These compounds may be synthesized in the body or obtained from the diet (Vertwani, 2004).

A paradox in metabolism is that while the vast majority of complex life requires oxygen for its existence, oxygen is a highly reactive molecule that damages living organisms by producing reactive oxygen species (Davies, 1995). Consequently, organisms contain a complex network of anti-oxidant metabolites and enzymes that work together to prevent oxidative damage to cellular components such as DNA, proteins and lipids (Sies, 1999; Vertuani et al., 2004). In general, anti-oxidant system either prevents these reactive species from being formed, or removes them before they can damage vital components of the cell (Sies, 1997; Davies, 1995). However, since reactive oxygen species do have useful function in cells, such as redox signaling, the function of anti-oxidant system is not to remove oxidants entirely, but instead to keep them at an optimum level (Rhee, 2006).

Low levels of anti-oxidants or inhibition of the anti-oxidant enzymes, cause oxidative stress and may damage or kill cells (Bonnefoy, 2002). As oxidative stress might be an important part of many human diseases (Jomova and Valko, 2011; Kregel and Zhang, 2007), the use of anti-oxidants in pharmacology is intensively studied, particularly as treatments for stroke and neurodegenerative disease (Hamid et al., 2010).

They are also widely used as ingredients in dietary supplements in the hope of maintaining health and preventing diseases such as cancer and coronary heart disease (Devasagayam et al. 2004). Although some studies have suggested anti-oxidant supplement have health benefits, other large clinical trials did not detect any benefit for the formulations tested and excess supplementation may be harmful (Bjelakovic, 2007).

This paper therefore highlights the anti-oxidant potentials of the spices in-combination within *Yaji* (a complex Nigerian meat sauce), since anti-oxidant drug alternatives are becoming inevitable

YAJI AND *YAJI* SPICES

Yaji is a complex Nigerian meat sauce (Nwaopara et al., 2004; Nwaopara et al., 2007). It is principally groundnut cake flour that has been mixed with different portion of grounded spices like ginger, alligator pepper and salted to taste (Adebesin et al., 2001). Groundnut flour is obtained by grinding groundnut cakes into fine size, which can be used in making soup, stew, sauces, confectioneries, puddings and bakery products (Adebesin et al., 2001). *Yaji* is a complex of spices and additives including ginger, cloves, red pepper, black pepper, white-maggi (Ajinomoto), salt, and groundnut cake powder (Nwaopara et al., 2007; 2008; Akpamu et al., 2011). The spices in *Yaji;* ginger, cloves, red pepper and black pepper, contain gingerol (Witchtcl, 2004), eugenol (Krishnaswamy and Raghuramulu, 1998), capsaicin (Collier et al., 1965; Sirsat and Khanolkar, 1966) and piperine (Mc Gee, 2004) as active principle respectively.

Considering its mass-consumption rate and complexity, *Yaji* has become the basis for several histological investigations with interesting findings (Nwaopara et al., 2004; Nwaopara et al., 2007; Nwaopara et al., 2008; Nwaopara et al., 2012). These investigations were aimed at determining the effect of excessive consumption of *Yaji* (or its constituent spices) on the Pancreas (Nwaopara et al., 2004), Liver (Nwaopara et al., 2007), Kidney (Nwaopara et al., 2008) and the Heart (Nwaopara et al., 2004). Results have shown that an excessive consumption of *Yaji*-spices especially in combination, is capable of inducing Pancreatic, Liver and Kidney tissue damage but with no significant effect on the histology of the Heart under the same experimental conditions (Nwaopara et al., 2004; Nwaopara et al., 2007; Nwaopara et al., 2008).

From these reported findings, one might conclude that the consumption of *Yaji* is always likely to produce a negative effect, which however, according to Nwaopara et al. (2009), should not be the case, because the emphasis in the experiments was on the effect of an excessive consumption. In fact, it is quite convincing that a moderated consumption of *Yaji* has the potential to produce positive results in some sense and such can be seen in its anti-oxidation potentials; considering the available information on the anti-oxidation properties of its constituent spices.

THE ANTI-OXIDANT POTENTIALS OF *YAJI* SPICES

Ginger

Ginger (Zingiber offinale Roscoe) has been shown to have a high content of anti-oxidants (Lee and Ahn, 1985; Kikuzaki and Nakatami, 1993; Kikuzaki et al., 1994) and researchers have been engaged in efforts to determine the structure of more than 50 anti-oxidants isolated from the rhizomes of ginger (Masuda et al., 2004). The non-volatile fraction of the dichloromethane extract of ginger rhizome exhibited a strong anti-oxidant activity using linoleic acid as the substrate in ethanol-phosphate buffer solution (Kikuzaki and Nakatani, 1993).

Available literature shows also that ginger significantly lowers lipid peroxidation by maintaining the activities of the anti-oxidant enzymes – superoxide dismutase, catalase and glutathione peroxidases in rats (Ahmed et al., 2000). In a study by Stoilva et al., (2007), ginger extract inhibited the hydroxyl radicals by 79.6% at 37^{o}C and 74.8% at 80^{o}C and this indicates a higher anti-oxidant activity than quercetin (Stoilva et al., 2007). Ginger has also been implicated in anti-oxidation by virtue of one of its component, magnesium, which was identified as an antioxidant by Anetor et al., (2003).

Clove

Scientists have discovered that clove contain a high concentration of anti-oxidants (Viuda-Martos, 2010). Some herbal teas and infusions traditionally used in the treatment of diabetes in Turkey have also been studied for their anti-diabetic effects on in-vitro glucose diffusion and phenolic contents and anti-oxidant activities (Buyuk-balci,

2008). It was discovered that clove and cinnamon which was commonly used in preparation of black tea in Turkey resulted to have synergistic effect on total anti-oxidant activities of black and peppermint teas (Buyuk-balci, 2008).

Other studies implicated eugenol -an active constituent of clove, in anti-oxidation (Jaganathan and Supriyanto, 2012; Scherer et al., 2009). Studies by Ogata and his colleagues, showed that eugenol and dieugenol are anti-oxidants but with different mechanism of anti-oxidation i.e. eugenol may inhibit lipid peroxidation at the level of initiation. However, the related dimeric compounds may inhibit lipid peroxidation at the level of propagation of free radical chain reaction like alpha-tocopherol (Ogata et al., 2000). Studies by Hideaki Kabuto and his colleagues showed that eugenol (2-Methoxy-4-C_2-propenyl phenol) prevents 6-Hydroxydopamine induced dopamine depression and lipid peroxidation inductivity in mouse striatum (Hideaki et al., 2006).

Ascorbic acid (vitamin C), which also is a constituent of clove (Eugenia caryophyllus), was identified as an anti-oxidant by Padayatty et al., 2003; Meister, 1994 and Shigeoka et al., 2002. The flavonoid components of clove (i.e. kaempferol and rhamnetin) were reported also to contribute to its anti-inflammatory and anti-oxidant properties (Friedman et al., 2002).

Red Pepper

Carotenoid and tocopherol, constituents of red pepper has been shown to have anti-oxidant potentials (Jack, 1996; Daood et al., 1996; Markins et al., 1998). In another study, the anti-oxidant activities of red pepper (Capsicum annum, L.) pericap and red pepper seed extracts were examined. All the extracts showed strong anti-oxidant activity by the testing methods (Sim and Sil, 2008). Hot Chilli pepper, already known to be a rich source of the anti-oxidant vitamin C, also contain high concentrations of a phytochemical called capsaicin (Ademoyegun et al., 2011).

Studies by Padayatty et al., 2003, Meister, 1994 and Shigeoka et al., 2002 identified vitamin C (ascorbic acid) a constituent of red pepper as an anti-oxidant. Studies by Herrera and Barbas, 2001; Packer et al., 2001 and Traber and Atkinson, 2007 identified vitamin E (tocopherol), a constituent of red pepper as an anti-oxidant. The hotter the pepper, the more capsaicin and anti-oxidants you will find (Nicepolicy16, 2009).

Black Pepper

Most evidence showing that black pepper is an anti-oxidant points directly to the involvement of piperine, its active principle, in anti-oxidation. Studies by Vijaya-Kumar and his colleagues showed that supplementation with black pepper or the active principle of black pepper, piperine, can reduce high-fat diet induced oxidative stress to the cells (Vijaya-kumar et al., 2004).

Black pepper contains several powerful anti-oxidants and is thus one of the most important species for preventing and curtailing oxidative stress. In addition to their direct anti-oxidant properties, several of these compounds work indirectly by enhancing the action of other anti-oxidants. This makes black pepper particularly valuable in minimizing the damage caused by diet rich in saturated fats, one of the main causes of oxidative stress (Keith, 2008). Studies by Neelima Pathak and Shashi Khandelwal showed that piperine has anti-oxidant potential which was directly proportional to their anti-apoptic potential (Neelima and Shashi, 2008).

In a rat intestinal model, piperine was said to produce protection against oxidative changes induced by a number of chemical carcinogens (Khajuria et al., 1998). Further studies by Khajuria et al., 1998 suggested that piperine modulates the oxidative changes by inhibiting lipid peroxidation and mediating enhanced synthesis of transport of GSH thereby replenishing thiol redox.

THE ASSOCIATED SIDE EFFECTS

Usage of the *Yaji* spices have increased so far especially due to their anti-oxidant potential but other studies suggest that they may have minor or major side effects ranging from irritation of the esophagus with black pepper (Ghadirian, 1992) up to liver failure with clove oil (Brown et al., 1992).

Clove may increase the risk of bleeding or potentiate the effects of warfarin therapy (Heck et al., 2000). The smoking of clove cigarettes have been associated with 13 cases of serious illness in the United States, including hemorraggic pulmonary edema, pneumonia, bronchitis and hemoptysis (Guidotti et al., 1989). More than a dozen cases of pulmonary toxicity have been reported in people who smoked clove cigarettes (Centre for Disease Control,

1985; Hackett et al., 1985). A case is present in which a 7-month old child developed central nervous system depression, urinary abnormalities and a large anion gap acidosis after the accidental oral administration of clove oil. Supportive care and gastric lavage were sufficient for total recovery of the patient (Lane et al., 1991).

A comprehensive search of the medical literature has not revealed any cases of ginger toxicity or adverse effects despite universal use as a flavoring throughout the world and sales in supplement form in health stores and pharmacies in the U.S.A. and Europe. This indicates that ginger is extremely safe, more so than most current OTC (Over-the-counter medications) (HerbalGram, 1996). Neither adverse effects nor drug interactions have been reported (Austin, 1998; Grant and Lutz, 2000).

Red pepper consumers are at high risk for gastric cancer compared with non-consumers (Lopez-Carrillo, 1994). Relatively large doses of vitamin C (a constituent of red pepper) may cause indigestion, particularly when taken on an empty stomach and even diarrhea in healthy subjects. The signs and symptoms in adults were nausea, vomiting, diarrhea, flushing of the face, headache, fatigue and disturbed sleep while the main toxic reactions in the infants were skin rashes (World Health Organization, 1973). As vitamin C enhances iron absorption (Fleming et al., 2002), iron poisoning can become an issue to people with rare overload disorders, such as haemochromatosis (Cook and Reddy, 2001).

Adverse effects following black pepper ingestion include rash, elevated hepatic enzymes, pulmonary hypertension and hepatitis (Mathews et al., 1988; Escher and Desmeules, 2001). Black pepper may also interact with benzodiazepines, inducing coma (Almeida and Grimsley, 1996). Black pepper irritates the esophagus (Ghadirian, 1992).

CONCLUSION

Yaji species possess anti-oxidant potentials but their consumption may be associated with minor or major side effects. As such, the need for appropriated regulation cannot be ignored despite their reported anti-oxidant potentials. It is important to note also, that despite benefits, an excessive *Yaji* spices as anti-oxidants should be avoided to avoid untoward consequences. In fact, the safest anti-oxidation strategy is to shun avoid lifestyle that induces or enhances oxidation like vigorous exercise, exposure to drugs or toxins and poor dieting.

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AUTHORS' CONTRIBUTIONS

Okpalaugo, O.C., performed the materials search and was involved in the preparation of this article.