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Full Length Research Paper

Lycopene Content of Selected Tomato Based Products, Fruits and Vegetables Consumed In South Western Nigeria

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ABSTRACT

Lycopene, a bright red carotenoid pigment has attracted substantial interest among the health professional due to its high antioxidant properties. The Lycopene content of selected tomato based products, fruits and vegetables, commonly consumed in South Western Nigeria were determined using theoretical and experimental method. The lycopene content in tomato pastes ranged from 50.97±1.08 mg/kg in vitali tomato paste to 68.12±1.44 mg/kg in Gino tomato paste. In the fruits, lycopene content ranged from 0.47±0.04 mg/kg in grape fruits (white) to 32.15±0.70 mg/kg in watermelon. Among the yellowish-red vegetables, lycopene content ranged from 14.88±0.70 mg/kg in red bell pepper to 45.49±0.98 mg/kg in ripe tomato fruit. In green leafy vegetables, lycopene ranged from 4.96±0.13 mg/kg in waterleaf to 11.79±0.28 mg/kg in bitter leaf. This study has shown that tomato paste is very rich in lycopene followed by fresh ripe tomato fruit, watermelon and fresh chili pepper. Bitter leaf and Pumpkin leaf were observed to have the highest lycopene content amongst the green leafy vegetables. Tomato paste, fresh tomato watermelon and pumpkin should be regularly included in the diet for adequate supply of lycopene

Keywords: Lycopene content, tomato pasted products, fruits and vegetables, South West, Nigeria

INTRODUCTION

Epidemiological evidence linked diet rich in fresh fruits and vegetable to protection against chronic degenerative diseases (Joshipura *et al*., 1999; Cox *et al*., 2000)
Cancer has emerged as a major public health problem all over the world. The burden of cancer in Nigeria is also appreciable and it is anticipated that in 2020 death rate from cancer in Nigeria males and females may reach a very high rate (Ogundipe and Obinna, 2008). The bottom line is that except urgent action is taken by the government, health practitioners, the research personnel and the general public; cancer rates are set to increase in an alarming rate globally (The World Cancer Research Fund, 2007).

The World Cancer Research Fund (2007) suggests that fruits and vegetables protect against several types of cancer. Numerous epidemiological studies also reveal a strong link between eating a diet rich in fruits and vegetables and protection against chronic diseases such as heart diseases and cancers in human (Hasler, 1998; Cho *et al*., 2004; Giovannucci *et al*., 2007). The dietary necessity of carotenoid compounds, especially the carotenoid beta-carotene, the precursor of Vitamin A, in

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the prevention of chronic diseases has been recognized for many decades (Steinmetz, 1996). More recently lycopene, a member of the carotenoid family of compounds has attracted the greatest interest among the carotenoids from the medical research (Levy and Sharon, 2004; Giovannucci *et al*., 2007). Lycopene is the red carotenoid pigment found predominantly in fruits and vegetables, most especially in tomato species (Basu and Imrhan, 2007).

Lycopene is also a major carotenoid in human blood found to have comparatively, stronger antioxidant properties than major plasma carotenoids (Cho *et al*., 2004; Levy and Sharon, 2004; Blum *et al*., 2006). Lycopene was reported to be a highly effective antioxidant owing to its ability to act as a free radical scavenger and has the highest singlet oxygen quenching rate of all the carotenoids tested from biological systems (Levy *et al*; 1995, Vecchioi, 2002, Rao and Rao, 2007).

Report indicates that human body is unable to synthesize carotenoids from endogenous produced chemicals and totally depends on exogenous (dietary) sources of carotenoids. Some medical research studies have reported fruits and vegetables, especially tomato as the good food sources of Lycopene (Stahl *et al*., 200, Heinrich *et al*., 2003, Etiman*et al*., 2004, Sesso *et al*., 2004). La, Vecchia (2002) had also revealed that high intake of tomato products reduced the risk of prostate cancer which is likely due to the action of the lycopene content. It would be useful to know the overall lycopene content of tomato based products, fruits and vegetable in each locality to establish how the information may translate into dietary intake to satisfy the need for lycopene and carotenoids by individual.

This study determined the lycopene content of tomato based products and some selected natural fruits and vegetables commonly consumed in Nigeria

MATERIALS AND METHODS

Sample Collection and preparation: Twenty varieties of tomato based products, fresh fruits and vegetable samples (tomato paste Ciao, Vitali, Gino and tomasonia) tomato sauce (Geshia), watermelon, grapefruit, orange, pawpaw, carrot, mango, pineapple, chilli pepper, redbell pepper, fresh tomato, waterleaf, spinach, pumpkin leaf, garden egg leaf and bitter leaf were obtained from four main markets in Ibadan. In the case of fruits, special care was taken to select the most mature samples

About 1-2kg of each sample of fruits and vegetables were obtained from each market outlet. The edible portion of fruits and vegetable samples from the different outlets were washed and rinsed with water several times and finally rinsed with deionized water to remove contamination. Each sample was cut into smaller pieces, homogenized to obtain a uniform single composite sample of the same type of fruits and vegetables. The varieties of tomatoes based products; fresh fruits and vegetable are shown in table 1.

Chemical Analysis: The chemical used for the analysis of the food samples include: Buthylated hydroxytoluene (BHT), acetone, hexane, ethanol, deionized water and lycopene standard.

The lycopene concentration was determined using a Jenway 6305 UV/vis spectrophotometer (Jenway Ltd. Felsted, Dunmow, Essex). Detection was carried out at 503nm to avoid interference from other carotinoid that might be present in the food samples.

Based on the reports of Fish, *et al*., 2002, Perkins-Veazie, *et al*., 2001, Sadler *et al*., 1990 and Ravelo-Perez *et al*., 2008 which suggested the use of the simple and rapid analytical method of determining lycopene carotenoids – rich samples by using a simple and rapid spectrophotometric method for extraction of lycopene from the food samples with hexane, the spectrophotometric method was employed to quantify the lycopene content in the food samples.

Preparation of Lycopene Standard

Lycopene standard solution in hexane (5mg/ml) was prepared and wrapped in a piece of paper foil and stored in the dark at 4^0C. Working mixtures of various pertinent concentrations were made by appropriate combination and dilution with hexane. The conjugated-double bond system of carotenoids in general could produce the main problems with their manipulation (they are unstable to light, oxygen, heat, acid and alkaline conditions). Thus, particular attention was paid on the sample/standard preparation, during manipulation and storage to prevent this interference. Several solutions of lycopene in n-hexane at different concentration were prepared ranging from 0.005-50mg/l and absorbance was measured at 503nm, after suitable calibration of the instrument with hexane. The graph of absorbance versus lycopene concentration (mg/L) in hexane ranging was plotted.

Extraction of Lycopene in the Food Samples

After the calibration curve was obtained, the extraction of lycopene from the food samples was performed according to Fish *et al*., (2002). Samples were first chopped and homogenized in a laboratory homogenizer. Approximately 0.5g of each food sample was weighed and 5ml of 0.05% (w/v) BHT in acetone, 5ml of ethanol and 10ml of hexane were added. The recipient was introduced into ice and stirred on a magnetic stirring

plate for 15min. after shaking, 3ml of deionized water was added to each vial and the samples were shaken for 5 minutes on ice. Samples were then left at room temperature for 5 minutes to allow for the separation of both phases i.e. the polar and non-polar phases.

Lycopene content of foods and tomato fruits was measured spectrophotometrically at 503 nm after an extraction with hexane (Sadler *et al*., 1990, Perkins-veazie *et al*., 2001 and Fish *et al*., 2002)

Concentration of lycopene was derived using the molar extinction coefficient of 17.2 x 10^4 in the theoretical method of Markoric *et al* (2006) and also by applying the following equation in the experimental method described by Ravelo-Perez *et al* (2008):

Lycopene content (mg/kg) = (A_{503} – 0.0007) x 30.3/g tissue

The Lycopene content of the selected food samples determined in this study was calculated using both the theoretical and experimental methods.

Statistical Analysis

The data obtained using the two methods were tabulated and the relative error of the two data was estimated. The mean of the two methods, standard deviation and test of significant difference were obtained using Statistical Package for Social Science (SPSS) version 16.0

RESULTS

A good straight line with the correlation coefficient of 0.995; $P<0.05$ was obtained for the calibration graph of the absorbance versus the lycopene concentration (mg/l) in hexane (ranging between 0 and 5mg/l).

The mean values of lycopene contents of the food samples using both the theoretical and the experimental methods are presented in Fig. 1.

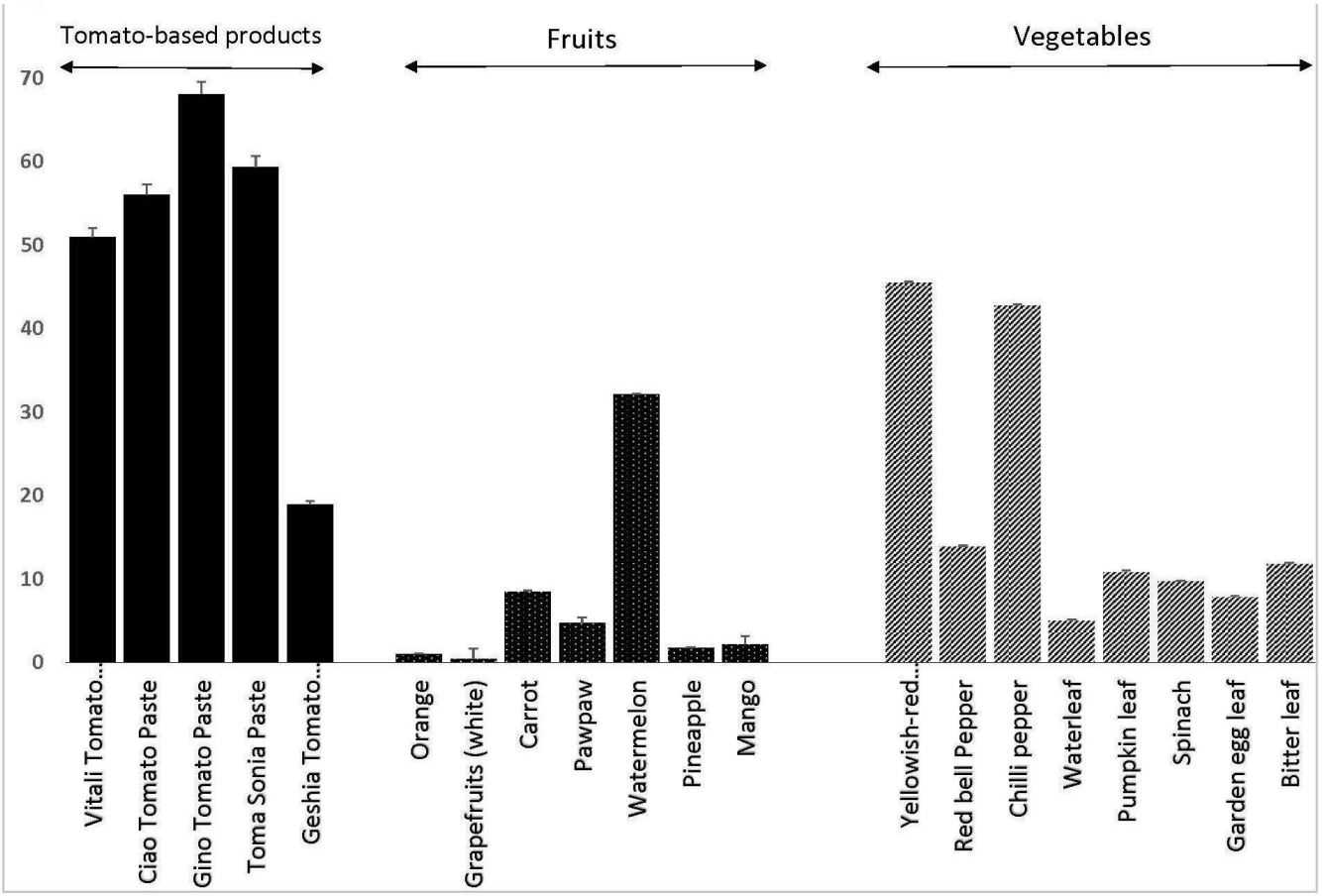

Fig. 1

Lycopene contents of tomato-based products, fruits and vegetables of Southwestern Nigeria, Each bar represents the Mean ± SEM of values obtained using the theoretical as well as experimental methods derived spectrophotometrically at 503nm absorbance.

Although the value obtained from the experimental method were generally higher than the theoretical method, the values obtained for each food sample using the two methods were not significantly different (P>0.05). Gino tomato paste had the highest lycopene content followed by Tomasonia tomato paste while Vitali tomato paste had the lowest lycopene content. Geshia tomato sauce had less lycopene content than all of the tomato pastes analyzed.

Lycopene varied widely among the various fresh fruits ranging from (0.47 ± 0.04 mg/kg) in grapefruits (white) to (32.15 $\pm$ 0.70 mg/kg) in red watermelon. The lycopene content in watermelon was significantly higher than the other selected fresh fruits ($p<0.05$).

Among the yellowish-red and green leafy vegetables fresh Tomato had the highest lycopene content followed by fresh chili pepper. The lycopene content of red bell pepper was significantly lower than in chili pepper or fresh tomato ($p<0.05$). Among the green leafy vegetables, bitter leaf had the highest lycopene content followed by pumpkin leaf while water leaf had the lowest lycopene content.

DISCUSSION

Lycopene is known to be one of the most potent antioxidant among dietary carotenoids (Argarwaland, 2000). Knowing the lycopene content of commonly consumed foods is useful in planning dietary strategies to satisfy the reference daily intake for antioxidant and also as useful indices of potential health benefits, of individual plant-based foods. The beneficial effects of fruits and vegetables are hypothesized, owing at least to their antioxidants contents (Collins, 1999).

The result presented in the study has shown that lycopene content varied widely among tomato based products, fruits and vegetables indicating the need of different servings of these foods. Among the food samples analyzed, tomato and tomato derived products had the highest content of lycopene.Lycopene content in the tomato based products commonly consumed in Nigeria was significantly higher than the commonly consumed fruits and vegetables ($P<0.05$). This observation is similar to the reports of Grossman *et al*., (2004) which indicates that tomatoes and tomato based sauces, juice and ketchup account for more than 85% of the dietary intake of lycopene of most people who include them in their diet. Our result also shows that the lycopene content in the selected tomato based product was significantly higher than in fresh tomato which is likely due to the higher moisture content of fresh tomatoes than the processed tomatoes paste. Khan *et al*., (2008) also reported that, lycopene in tomato pastes was four times more bioavailable than in fresh tomato.

According to report of Khan *et al*., (2008), cooking and crushing of tomatoes (as in canning process) and with addition of serving oil, greatly increases the assimilation of lycopene from the digestive tract, into the bloodstream. Lycopene is fat soluble thus oil helps its absorption (Khan, et. al., 2008). This indicates that individual should include a lot of tomato, especially tomato paste in combination with some edible oil in his/her meals.Regular intake of fruits and vegetables, with inclusion of tomato based products, may result in regular intake of 20mg lycopene or more /day (EPSA, 2005).

Based on the results obtained from this study, within the tomato based products analyzed, Gino tomato paste had the highest lycopene content. According to Etminam *et al*., (2004), daily intake of one or more serving of tomato, tomato products or lycopene supplements may play a role in the prevention of prostate cancer. Giovannucci *et al*., (2007) also suggests that increased consumption of tomato based products (especially cooked tomato products) and other lycopene containing foods may reduce the occurrence of prostate cancer. This indicates that adequate intake of tomato pastes, tomato fruits, water melon and other fruits and vegetables may help reduce the incidence of prostate cancer in the community.

The report of Perkins Veatie *et al*., 2006 indicates variability in the lycopene content of the different fruits.Among the fresh fruits analyzed in this study, red watermelon had the highest content of lycopene. The lycopene value obtained for the red watermelon is within the range stated in the literature. This indicates that red watermelon is rich in lycopene. Thus,individual is encouraged to take red watermelon liberally.

Within the yellowish-red vegetable group fresh tomato had the highest concentration of lycopene content. The value obtained is also within the range reported by Ravelo-Perez *et al*., (2007) and Khachick *et al*., (1992). However, all the tomato based products had higher amount of lycopene content than the fruits and vegetables analyzed.According to Silaste *et al*., (2007), a diet rich in lycopene cut the risk of prostate cancer by 45%. Lycopene is also known to lower the risk of colorectal cancer, stomach cancer and it also inhibits the growth of other types of cancer cells. Although, the issue of the bioavailability of these food-based products was not determined in this study; nonethelessthe information is useful in planning dietary strategies and is a useful index of potential health benefits.

In conclusion, this study has shown that tomato based products especially tomato pastes, is a very rich

source of lycopene; red watermelon is significantly high in lycopene compared to other fresh fruits while fresh bitter leaf and pumpkin had the highest lycopene content among the green-leafy vegetables, commonly consumed in the South Western part of Nigeria.

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