Effect of Combined Intake of Garcinia Kola and Ascorbic Acid on Intraocular Pressure of Normotensive Nigerians.

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Abstract

This study was carried out to determine the effect of combined intake of Garcinia kola and Ascorbic acid on Intraocular pressure (IOP) of normotensive Nigerians. A total of one hundred and sixty (n= 160) participants, males, and females within the age range of 18-50 years (Mean age = 29.29± 8.74) were used for this study. The participants were randomly assigned to four groups: A, B, C, D (n=40 in each group). About 500mg of Ascorbic acid only was administered to subjects in Group A; 7.4g of Garcinia kola only was administered to subjects in Group B; combined 7.4g of Garcinia kola and 500mg of Ascorbic acid was administered to subjects in group C, while 100ml of water was administered to Group D to serve as a control. The IOP of each subject was measured with a Tonopen Tonometer pre and post ingestions of the assigned treatment at 30 minutes interval for 120 minutes. The findings showed a statistically significant reduction ($p< 0.05$) in mean IOP from baseline values in groups A, B, and C at 60minutes and 90 minutes post administration of assigned treatment, with peak reduction at 60 minutes. The percentage change in mean IOP at 60 minutes in Groups A, B, C were 6.76%, 15.07%, 23.04% respectively. This change was statistically significant ($p<0.05$) in the three groups, with group C recording the highest reduction in mean IOP. There was, however, an increase in mean IOP towards baseline after 60 minutes. Group D recorded no statistically significant change in mean IOP. The reduction in mean IOP recorded in group C was statistically significant at all times of assessment post ingestion. ($P<0.005$). It was concluded from this study that combined intake of Garcinia kola and Ascorbic acid had a greater effect on IOP than Garcinia kola or Ascorbic acid alone. However, this effect was transient, since the reduction was not sustained after 60 minutes of ingestion. This may form the basis for the development of affordable medicine for lowering IOP.

Keywords: Garcinia kola, Ascorbic acid, intraocular pressure, tonometer.

Introduction

The spaces within the eye are filled with a clear fluid, the aqueous humour and a jelly, the vitreous body. The aqueous humour is contained in the anterior and posterior chambers, while the vitreous body is contained in the large space between the lens and the retina[1]. The tissue pressure of the intraocular contents is called the intraocular pressure (IOP)[1]. The intraocular pressure is a function of the rate at which aqueous humour enters the eye (inflow) and the rate at which it leaves the eye (outflow) through the trabecular meshwork.

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When both inflow and outflow are equal, a steady state exists, and the intraocular pressure remains constant. Any factor which disrupts the relationship between the inflow and outflow of the aqueous humour will invariably affect the intraocular pressure. A disruption in favour of increased aqueous humour production (inflow) or decreased aqueous humour outflow will cause an increase in intraocular pressure, while a disruption in favour of decreased aqueous humour production and increased aqueous outflow will cause a decrease in the intraocular pressure. In the chronic setting, raised intraocular pressure may cause nerve damage at the head of the optic nerve leading to visual field loss – Glaucoma. This may be due to the direct effect of raised pressure upon the nerves, or the effect of chronic under-perfusion of the nerve head.

Glaucoma is a heterogeneous group of eye diseases characterised by damage to the optic nerve usually (but not always) due to excessively high Intraocular pressure (IOP). This increased pressure within the eye, if untreated can lead to optic nerve damage resulting in progressive, permanent vision loss, starting with the unnoticeable blind spots at the edges of the field of vision, progressing to tunnel vision, and then blindness. High Intraocular Pressure without clinical signs of optic nerve damage or visual field loss is called ocular hypertension. High IOP is the highest risk factor of glaucoma[2]. According to Quigley, glaucoma is the second leading cause of vision loss in the world after cataract[2]. At present all resources are directed towards reduction of intraocular pressure, the only known causal and treatable risk factor for glaucoma[3].The "prevalence of glaucoma in Nigeria is on the increase from 4% in 1998 to 23% in 2006[4]". The poor and rural dwellers are not spared of the scourge. Medication and /or surgery are used to lower the intraocular pressure (IOP) in order to reduce or stop the progression of the disease. In Nigeria, "the most commonly available IOP reducing agents are B-blockers (mainly timolol maleate 0.5% eye drops) and prostaglandins, mainly latanoprost 0.005% which are expensive and out of reach of the poor and rural dwellers with attendant poor compliance with long-term use in Nigerian patients"[5]. With so many adverse effects connected with the use of most of the popularly used intraocular pressure reducing agents in the country, there is certainly a need for the search for a safer and equally effective medication. The challenge, therefore, is to search for an alternative medication that is affordable, available and effective in lowering the IOP amongst the poor populace, especially rural dwellers.

Historically, plants have provided a source of inspiration for novel drug compounds, as plants derived medicines have made large contributions to human health and well-being[6]. Their role is two ways in the development of new drugs[7]. They may become the basis for the development of new medicine i.e. a natural blueprint for the development of new drugs, or aphytomedicine to be used for the treatment of disease.

Garcinia kola (*Heckel Guttiferae*) is "natural vegetation native to Africa and Asian countries. It is an indigenous herb in Nigeria and widely available all year round. It prevails as a multipurpose tree crop in the home gardens of Southern Nigeria. The tree is usually cultivated within villages in Southern Nigeria, grows to a height of about 12-14m and produces reddish, yellowish or orange coloured fruit"[7,8]. The fruits are named bitter kola or male kola, *Orogbo* in Yoruba, *Agbailu* in Igbo, *Adu* in South Mid-West and *Naminjigoro* in Hausa"[5]. Each fruit contains 2-4 yellow seed, sour tasting pulp and the seed has only one cotyledon[7]. They have, in chewing a bitter astringent and resinous taste, somewhat resembling that of the raw coffee bean with a

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resident slight sweetness[9]. Garcinia kola constituents include crude protein, lipid extracts, ash and crude fiber; flavinoids (bioflavinoids), xanthenes and benzophenones[10]. Garcinia kola is highly valued because of its medicinal use and the seeds are chewed as an aphrodisiac or used to cure cough, dysentery, chest colds in herbal medicine[7]. The seeds of Garcinia kola form a major part of the herbal preparations used in traditional African medicine practice for the treatment of various diseases[11]. Garcinia kola nut crude water extracts was experimented upon with laboratory animals' eyes and the result revealed its intraocular pressure lowering and miotic effect[12]. Adefule-Ositelu et al studied the antibacterial effects of Garcinia kola nut extracts on ocular bacterial isolates in Lagos and reported that the water extract has strong inhibitory activities on *Escherichia coli, Enterococcus faecalis, Proteus mirabilis*[13]. The methanol extract only inhibited *Staphylococcus aureus* and *Pseudomonas aeruginosa* better. Both extracts inhibited *Staphylococcus albus* equally. When the effects of 5% of the water extract were compared with that of 0.05% Ciprofloxacin, there was no statistically significant difference. They concluded that these results give evidence of some antibacterial activities in Garcinia kola nut extracts.

According to Okojie et al, Garcinia kola is used in folklore remedies for the treatment of ailments such as hepatitis, diarrhoea, laryngitis, bronchitis and gonorrhoea[7]. Garcinia kola clinically appeared to have a significant analgesic/anti-inflammatory effects in knee osteoarthritis patients and thus a potential osteoarthritis disease modifier[14]. Garcinia kola is primarily carried bound to albumin in the blood and only a minor amount is metabolised by hepatic metabolism[14]. Unlike other kola nuts, Garcinia kola is believed to clean the digestive system without side effects such as abdominal problems, even when a lot of nuts are eaten[15]. "The excretion has neither an organ nor behavioural abnormalities. Most of the studies on the pharmacological activity of phytochemical components of Garcinia kola seed have been on the bioflavonoid. These phytochemicals have been shown to have a very broad spectrum of pharmacological activity: protective action against chemical induced haemolysis in G6PD deficient human red blood cells; anti-inflammatory antipyretic activity; inhibition of hepatic drug metabolism and anti hepatoxicity"[16].

Ascorbic acid or vitamin C is a physiologically important compound which is a carbohydrate derivative[17]. Ascorbic acid is an enediol-lactone of an acid and water soluble with a configuration similar to that of sugar, L-glucose[18]. Ascorbic acid is sensitive to heat and, therefore, lost by cooking and it is destroyed when exposed to sunlight. It cannot be stored in the body and therefore the daily supply of this vitamin is a must[19]. Ascorbic acid is widely distributed in both plants and animals (except man, monkey and guinea pig), occurring as both ascorbic acid and dehydroascorbic acid[20]. Fruits, vegetables, liver and kidney are generally the best sources, only small amounts are found in muscle meat[19]. Plants synthesize L- ascorbic acid from carbohydrates. Most seeds do not contain ascorbic acid but start to synthesize it upon sprouting. Some plants are believed to accumulate high levels of ascorbic acid (for example, fresh tea leaf, berries, and guava). For practical reasons, citrus

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fruits are good daily sources of ascorbic acid, as they are generally eaten raw and are therefore not subjected to cooking procedures that can destroy ascorbic acid[20]. The ascorbic acid contents of most foods decrease dramatically during storage due to the aggregate effects of several processes by which the vitamin can be destroyed. The official recommended daily dosage of ascorbic acid is 60mg/day (100mg/day for smokers)[20]. It is vital to note that the recommended daily administration (RDA) is not based on what is required for optimum health. The RDA is based on the ascorbic acid content of the average diet. Many experts have now realized that the RDA of 60mg/day is rather low to provide optimum health and protection against diseases and degenerative aspects of ageing[20].

Ascorbic acid functions in a number of biochemical reactions, mostly involving oxidation. There is clear evidence that ascorbic acid is required for the hydroxylation of lysine and proline in protocollage. Thus, ascorbic acid is obviously important for wound healing, since the connective tissue is usually laid down first[21]. Ascorbic acid is said to enhance the human immune defense system and this it does by enhancing the random migration of human polymorphonuclear leucocytes to the site of infection[22]. There is increasing epidemiological evidence that increased intake of ascorbic acid may help reduce the risk of diseases associated with increased oxidative stress. With regular intake, the ascorbic acid absorption rate in the body varies between 70 to 95%[23]. However, the degree of absorption decreases as intake increases. "At high dietary doses (corresponding to several hundred mg/day in humans) ascorbates is accumulated in the body until the plasma levels reach the renal absorption threshold, which is about1.5mg/dl in men and 1.3mg/dl in women"[23]. Concentrations in the plasma larger than this value (thought to represent body saturation) are rapidly excreted in the urine with a half-life of about 30minutes. Concentrations less than this threshold amount are actively retained by the kidneys, and the excretion half-life for the remainder of the ascorbic acid store in the body thus increases greatly, with the half-life lengthening as the body stores are depleted. Ascorbic acid can be oxidized (broken down) in the human body by enzyme L-ascorbate oxidase. Ascorbate that is not directly excreted in the urine as a result of body saturation or destroyed in other body metabolism is oxidized by this enzyme and removed[22]. High dose of Ascorbic acid has been reported to lower intra ocular pressure[24]. *Garcinia kola* has also been reported to lower Intra ocular pressure[25]. However, there has not been any investigation on the combined effect of both Ascorbic acid and *Garcinia kola* on intra ocular pressure.

Materials and methods

This was a cross-sectional study to investigate the effect of combined intake of Garcinia kola and ascorbic acid on the intraocular pressure of normotensive Nigerians. Participants for this study were volunteers from patients that visited Modupe Eye Centre, Ogbomoso, Oyo state of Nigeria; Ladoke Akintola University of Technology, Ogbomoso; and The Baptist Theological Seminary, Ogbomoso. A total of 160 participants were used for this study (95 Males and 65 Females). The age range was 18 to 50years. Participants gave informed consent and the study was carried out in accordance with the guidelines of the Declaration of Helsinki for the use of human subjects.

Inclusion Criteria

Participants recruited for this study were between the ages of 18 and 50 years. They had baseline intraocular pressure between 13mmHg and 21mmHg and no glaucomatous optic nerve head cupping.

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Exclusion Criteria

Participants were excluded if they had any ocular disease, systemic disease, contraindication to Garcinia kola (hypotension, palpitation, and dizziness), gastrointestinal ulcer, and Glucose-6-phosphate dehydrogenase (G-6-P) deficiency. Smokers and alcoholics were also excluded.

Preparation of Garcinia kola

Dried Garcinia kola seeds were purchased from Arada market (a popular local market in Ogbomoso) and identified by a professor of Botany at the LadokeAkintola University of Technology, Ogbomoso. The dark brown covers were peeled off manually. The yellowish seeds were taken to the Chemistry Department of the Ladoke Akintola University of Technology, for weight measurement by a Technologist using BRAINWEIGH® 5000 OHAUS® balance, and measurement by difference method. Ten randomly selected sizes of Garcinia kola seeds were measured and the following weights obtained:(a) 10.7g;(b) 7.8g; (c) 5.5g; (d) 6.1g; (e) 6.2g; (f) 8.8g; (g) 5.8g; (h) 6.2g; (i) 8.3g; (j) 9.0g.The average was calculated to be 7.4g. Garcinia kola seed weights of 7.4g were then measured and each packed in a nylon drug envelope and kept in the refrigerator until they were used for this study.

Preparation of Ascorbic Acid

Ascorbic acid tablets (100mg) manufactured by Tuyil pharmaceutical industries was purchased from a reputable pharmaceutical store in Ogbomoso. Five tablets (500mg) were packed in each nylon drug envelop and kept in the refrigerator until they were used for this study.

Screening of Participants

After informed consent, volunteers were invited to Modupe eye clinic where they were screened using the inclusion and exclusion criteria. Each volunteer was screened by the researcher. Blood pressure was measured using a Digital blood pressure monitor and external ocular examination done with a diffuse illumination after taking the visual acuity.

Funduscopy was performed with a direct ophthalmoscope to assess the integrity of the optic nerve head. The intraocular pressure was then measured with a TonoPen after instillation of a drop of Proparacaine Hydrochloride 0.5% Ophthalmic Solution to anesthetize the cornea. Only volunteers that met the inclusion and exclusion criteria were accepted as subjects for the study. Each participant was randomly assigned to one of the four groups. Appointment for the study was booked at the participants' convenience.

Procedure

Participants were randomly assigned to four different groups (of 40 each) –and treatment administered as follows: Group A: 500mgof Ascorbic acid only was administered to subjects in this group. Group B: 7.4mg of Garcinia kola only was administered to subjects in this group. Group C: combined 500 mg Ascorbic acid and 7.4 mg Garcinia kola was administered to subjects in this group. While Group D: 100 ml of water was administered to subjects in this group. All treatments were administered orally.

Intraocular Pressure Measurement Procedure

The entire study was carried out in the consulting room of Modupe Eye Clinic, Ogbomoso. Having satisfied the inclusion and exclusion criteria, each subject was made to sit comfortably on the examination chair with eye fixation at the primary position and the 6/60 letter on the Snellen distance chart used as a fixation point. A drop of proparacaine hydrochloride 0.5% ophthalmic solution was instilled into the eyes and the subject instructed to close the eyes gently for about 5 seconds. A sanitized tip cover was placed on the TonoPen and the instrument calibrated for use. IOP measurement was taken for each subject and recorded as Baseline IOP. The specimen (Garcinia kola,

Ascorbic acid only or Garcinia kola plus Ascorbic acid) belonging to the participant's group was then administered orally (by chewing) to the subjects. Intraocular pressure measurements were taken at 30 minutes interval up to 120 minutes post ingestion of treatment for each group.

Quality assurance for reliability of data collected for the study

To ensure the exclusion of the effects of as many extraneous factors as possible from the study, the following precautions were taken: All measurements were taken with the subject's eyes in the primary position (straight ahead) of gaze. This is to rule out the effect of direction of gaze on the intraocular pressure. The same examination seat was used to conduct the study to rule out the effect of varying positions on the intraocular pressure. All measurements were taken by the researcher, to ensure uniformity in findings and were taken between 12.00 noon and 4.00pm each day to avoid diurnal variation of IOP. Participants were advised to stay away from alcohol during the time of study as alcohol reduces the intraocular pressure. To stay away from aspirin as it has been shown to increase the rate of ascorbic acid's excretion from the body. Not to drink water, tea or coffee within two hours of intraocular pressure measurement, as they have been shown to raise the intraocular pressure.

Data Analysis

The analysis was done using SPSS (statistical package for social sciences), version 21.0 for Windows. Descriptive statistics using percentage frequency distribution mean and the standard deviation was employed; while t-test (unpaired and paired) and one-way analysis of variance (ANOVA) was used to analyse the data for this study. Post Hoc using Scheffe was done for significance shown by ANOVA. The level of significance was set at $p<0.05$

Results

A total of one hundred and sixty (n=160) subjects with mean age 29.99± 8.74 years (range 18 to 50 years), were recruited for this study. After ingestion of Ascorbic acid the difference between IOP at 30 minutes compared with baseline IOP was not statistically significant (t=1.778, p=0.083) but a change in IOP was statistically significant at 60 minutes and 90 minutes (t=9.294, p=0.000 and t=6.296, p=0.000) respectively. The difference in IOP was not statistically significant at 120 minutes (t=1.955, P=0.058).

The mean change in IOP at all times of assessment after ingestion of Garcinia Kola only was statistically significant as compared with baseline IOP. (At 30 minutes, t=3.766, p=0.001; at 60 minutes, t= 18.043, p 0.000; at 90 minutes t=20.158, p=0.000; at 120 minutes t=3.606, p=0.001). Compared with water, there was statistically significant difference in IOP at all times of assessment.

The change in mean IOP at all times of assessment after ingestion of combined Garcinia Kola and Ascorbic acid was statistically significant (at 30 minutes, t=8.530, p=.000; at 60 minutes, t=29.32, p=0.000; at 90 minutes, t=25.058, p=0.000; at 120 minutes, t=15.227, p=0.000).Compared with the control (water), there was a statistically significant difference at all times of assessment.

To find out if there was any statistically significant difference between all treatments at all times of assessment, ANOVA and post Hoc tests analyses were used. At time = 0 minute, the statistical difference in mean IOP between all treatments was not significant (p=0.062). Similarly, the difference in mean IOP at 30 minutes between all treatments was not statistically significant (p=0.100).At time = 60 minutes, the difference in mean IOP between all treatments was statistically significant (p=0.000).Post Hoc tests at 60 minutes showed there was a statistically significant difference between Garcinia Kola + Ascorbic acid and Garcinia Kola only; there was a statistically significant difference between Garcinia Kola+ Ascorbic acid and Ascorbic acid only; there was a statistically significant difference between Garcinia Kola only and Ascorbic only.

and Ascorbic only. There was also a statistically significant difference between the three treatments and control (water).

Similarly, there was a statistically significant difference in mean IOP reduction between all treatments at 90 minutes (p=0.000).At Time = 120 minutes, the difference in IOP between all treatments was statistically significant (P=0.006). However, Post Hoc test at 120 minutes showed statistically significant difference only between combined Garcinia Kola + Ascorbic acid and water. No statistically significant difference between all other treatments at 120 minutes.

Discussion

Intraocular pressure is the only known causal and treatable risk factor for glaucoma. In this study, oral administration of Ascorbic acid was found to induce 0.5% (0.08mmHg) reduction in IOP after 30 minutes of ingestion; 6.76% (1.03mmHg) reduction of IOP after 60 minutes; 4.12% (0.63mmHg) reduction in IOP after 90 minutes; and 0.81% (0.13mmHg) reduction after 120 minutes of ingestion. This supports a study by Linner which showed a marked fall in Intra ocular pressure following oral administration of 0.1 to 0.5g per Kilogram weight of Ascorbic acid[26].

Virno, as cited by Danford and Munro, obtained an average IOP reduction of 3.5mmHg from the administration of 0.5g/kg body weight of ascorbic acid[21]. He believed the mechanism to be due to the blood acidosis produced by the high dose of ascorbic acid, which according to him alters the blood-aqueous barrier to hinder aqueous formation. Linner also explained that the fall in pressure in ocular hypertension (after oral intake of ascorbic acid) was due to a reduction in the rate of aqueous flow and possibly by "bulk drainage by way of posterior uveo-scleral routes"[26]. Timothy and Okeke[27] observed that ascorbic acid has been established to support the osmotic influx of water following osmolarity elevation of blood artificially, leading to the fall of intraocular pressure.

This study also showed that oral administration of Garcinia kola induced 2.49% (0.40mmHg) reduction in mean IOP after 30 minutes of ingestion; 15.07% (2.40mmHg) mean IOP reduction after 60 minutes; 12.38% (1.98mmHg) reduction in mean IOP after 90 minutes; and 1.50% (0.25mmHg) reduction in mean IOP after 120 minutes of ingestion (Table 4). This is consistence with the work of Iyamu and Ajayi who reported a reduction in mean IOP at 30 minutes (0.50mmHg); 60 minutes (0.90mmHg) and 90 minutes (0.90mmHg)[25]. The difference in the mean IOP reduction between this study and theirs may be due to the difference in the source of materials used. This is in line with the work of Eleyimi et al, who reported a difference in the proximate and elemental composition of Garcinia kola from the works of others (Dosunmu and Johnson [1995] and Arogba [2000] respectively), due to the difference in the source of material used[10]. Iyamu and Ajayi attributed the IOP decrease to amines which are vasoconstrictors and nitroso-N-methyl urea, a systemic hyperosmotic agent and that these constituents of Garcinia kola implicated in intra ocular pressure reduction actually caused a decrease in the volume of aqueous humour[25]. Adefule-Ositelu et al concluded that Garcinia kola nut extracts surely can be useful in the management of glaucoma through its combined effects of reduction of aqueous humour formation, improving drainage of aqueous humour by its miotic effects and improvement of ocular blood flow through vasodilation[28].

Reduction of IOP with combined intake of Garcinia kola and Ascorbic acid in this study followed the trend observed in intake of Ascorbic acid only and Garcinia kola only, but caused a higher percentage of reduction in mean IOP. In this study, combined intake of Garcinia

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kola and Ascorbic acid caused a reduction of mean IOP by 6.30% (1.08mmHg) after 30 minutes of ingestion; 23.04% (3.90mmHg) after 60 minutes; 21.51% (3.65mmHg) after 90 minutes; and 12.60% (2.15mmHg) reduction after 120 minutes of ingestion. Like in the reduction of mean IOP by Ascorbic acid only and Garcinia kola only respectively, this study showed a consistent reduction of mean IOP by combined intake of Garcinia kola and Ascorbic acid which peaked at 60 minutes (23.04% or 3.90mmHg). This decrease in IOP was however not sustained after 60 minutes post-consumption. The IOP reversed towards baseline afterward. The decrease in IOP was, however, higher with combined intake of Garcinia kola and Ascorbic acid at all times of assessment than with other treatments (Ascorbic acid only and Garcinia kola only respectively).

The IOP reduction by Ascorbic acid was statistically significant at 60 minutes and 90 minutes ($p<0.05$) but was not statistically significant at 30 minutes and 120 minutes ($p >0.05$). On the other hand, there was a statistically significant reduction in IOP at all times of assessment by Garcinia kola only and combined intake of Garcinia kola and Ascorbic acid respectively ($p<0.05$). These confirmed the already established fact that Ascorbic acid and Garcinia kola reduces IOP. According to Trygre, 1.50% of the anterior chamber contents are renewed each minute and the half life of anterior chamber aqueous is some 45 minutes corresponding to a daily production of about 2.80ml[29]. Therefore, when Garcinia kola and Ascorbic acid are ingested and its constituents absorbed into the system, they reach the eye and lower the IOP probably through different mechanisms.

According to Timothy and Okeke, Ascorbic acid has been established to support the osmotic influx of water following osmolarity elevation of blood artificially leading to the fall in intra ocular pressure[27]. In inhibiting adenosine, the Garcinia kola extract is inhibiting the active process of aqueous secretion mediated through selective transport of ions across the basolateral membrane of nonpigment ciliary epithelium[28]. The reversal of IOP reduction at 90 minutes and 120 minutes of assessment was probably due to an insufficient amount of Garcinia kola and Ascorbic acid in the anterior chamber to continue the reduction of IOP.

In this study, we believe that the greater reduction in mean IOP by combined intake of Garcinia kola and Ascorbic acid than other treatments may be due to thecombined effects of reduction of aqueous humour formation, improving drainage of aqueous humour by its miotic effects and improvement of ocular blood flow through vasodilation(by Garcinia kola), and the osmotic influx of water following osmolarity elevation of blood artificially(by Ascorbic acid), leading to the fall in intra ocular pressure.

Conclusions

From the findings in this study, the following conclusions were made: Garcinia kola caused a reduction in intraocular pressure, Ascorbic acid caused a reduction in intraocular pressure, while the combined intake of Garcinia kola and Ascorbic acid caused a higher reduction in intraocular pressure than Garcinia kola only and Ascorbic acid only.

The reduction of IOP by combined intake of Garcinia kola and Ascorbic acid was transient. Glaucoma is the second leading cause of vision loss in the world and at present, all resources are directed towards reduction of intraocular pressure, the only known causal and treatable risk factor for glaucoma. In view of this fact, we hereby recommend that further studies be carried out using different sources of Garcinia kola, since it has been observed that proximate and elemental composition may vary, depending on the source of materials used for the study. We recommend a further study using ocular hypertensives and glaucoma patients as subjects.

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28. Adefule-Ositelu AO, Onakoya AO, Adefule AK, Dosa BOS. Comparative chromatographic analysis and pharmacodynamic activities of garcinia kola nut extracts. Nigeria Journal Hospital Medicine.2005;15(1): 30-33.
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Table 1
Distribution of participants by groups in the total population

Group	N	Mean Age (Years)	Std. Deviation
An (Ascorbic acid only)	40	28.03	8.28
B (Garcinia Kola only)	40	29.65	9.80
C (Garcinia Kola + Ascorbic acid)	40	27.98	8.17
D (Water)	40	31.53	8.47

Table 2
Mean IOP at all times of assessment after ingestion of water only

Time of assessment (min)	Mean (mmHg)	SEM
Baseline 0'	16.18	0.77
30'	16.01	0.01
60'	16.01	0.00
90'	16.01	0.01
120'	16.01	0.01

Table 3
Mean IOP before and after treatment in all groups

Time of Assessment (In Minutes)	Mean IOP (mmhg ± SEM)							
	Ascorbic Acid Only		Garcinia Kola Only		Combined Garcinia Kola & Ascorbic		Water	
	OD	OS	OD	OS	OD	OS	OD	OS
0	15.40 ± 0.22	15.30 ± 0.22	15.98 ± 0.24	15.78 ± 0.21	17.10 ± 0.32	16.83 ± 0.32	16.18 ± 0.77	15.65 ± 0.18
30	15.32 ± 0.23	15.15 ± 0.22	15.58 ± 0.25	15.15 ± 0.19	16.03 ± 0.32	15.65 ± 0.34	16.01 ± 0.01	16.01 ± 0.00
60	14.38 ± 0.26	14.23 ± 0.23	13.58 ± 0.25	13.28 ± 2.00	13.20 ± 0.33	13.08 ± 0.36	16.01 ± 0.00	16.01 ± 0.00
90	14.78 ± 0.25	14.72 ± 0.23	14.00 ± 0.23	14.00 ± 0.23	13.45 ± 0.33	13.43 ± 0.32	16.01 ± 0.01	16.01 ± 0.00
120	15.28 ± 0.23	15.13 ± 0.22	15.73 ± 0.22	15.63 ± 0.20	14.95 ± 0.32	14.40 ± 0.33	16.01 ± 0.01	16.00 ± 0.00

Table 4:
Mean change in IOP at different times of assessment after ingestion of Ascorbic acid only.

Time of assessment (min)	Mean IOP (mm Hg)	SEM	Mean change in IOP (mmHg)	% change in mean IOP (%)
0 (Baseline)	15.40			
30	15.33	0.23	- 0.08	0.50
60	14.38	0.26	- 1.03	6.76
90	14.78	0.25	- 0.63	4.12
120	15.28	0.23	- 0.13	0.81

Table 5
Mean change in IOP at different times of assessment after ingestion of Garcinia kola only.

Time of assessment (min)	Mean IOP (mm Hg)	SEM	Mean change in IOP (mmHg)	% change in mean IOP (%)
0 (Baseline)	15.98			
30	15.58	0.25	- 0.40	2.49
60	13.58	0.25	- 2.40	15.07
90	14.00	0.23	- 1.98	12.38
120	15.73	0.22	- 0.25	1.50

Table 6
Mean change in IOP at different times of assessment after ingestion of combined Garcinia kola and Ascorbic acid.

Time of assessment (min)	Mean IOP (mm Hg)	SEM	Mean change in IOP (mmHg)	% change in mean IOP (%)
0 (Baseline)	17.10			
30	16.03	0.32	- 1.08	6.30
60	13.20	0.33	- 3.90	23.04
90	13.45	0.33	- 3.65	21.51
120	14.95	0.32	- 2.15	12.60