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Research Article

Effect of Lemon Extract on Blood Pressure and Visual Functions of Normotensive in Young Adults

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ABSTRACT

This study determined the effect of lemon extract (30 ml) on blood pressure and some visual functions of young adults. Fifty subjects 20 males and 30 females were used for this study within ages 16-27 years with mean age of 21 ± 3.39 years (Mean ± SD). The baseline readings of blood pressure, near point of accommodation, near point of convergence and pupil size were taken and recorded prior to the administration of lemon extract. The Blood Pressure (BP), Near Point of Accommodation (NPA), Near Point of Convergence (NPC) and pupil size were measured and recorded 30 minutes, 1 hour, 1 hour 30 minutes and 2 hours post administration. The mean BP was 114.54 ± 6.7 mmHg/75.50 ± 5.29 mmHg and decreased to 97.74 ± 8.67 mmHg/65.82 ± 5.72 mmHg at 1 hour and increased towards baseline at 2 hours to 110.86 ± 9.52 mmHg/73.46 ± 7.11 mmHg. The mean NPA decreased from 8.13 cm ± 0.94 cm to 6.95 cm ± 0.89 cm at one hour and increased towards baseline at 2 hours 7.70 cm ± 0.79 cm. The mean NPC decreased from 8.17 cm ± 0.96 cm to 7.24 cm ± 0.74 cm at 1 hour and increased towards baseline at 2 hours, while pupil size decreased from 3.88 mm ± 1.04 mm to 2.77 mm ± 0.29 mm at 2 hours 3.44 mm ± 0.74 mm. Using the Z-test statistical analysis there was significant statistical effect on BP, NPA, NPC and pupil size. It is recommended that lemon be used as a supplement in management of hypertension and convergence insufficiency.

Keywords: Lemon; Blood pressure, Pupil size; Context

INTRODUCTION

Visual perception starts with the light emitted from reflection from man, object or a scene entering the eyes through the cornea, pupil and lens. Vision not only provides the early warning system for threat to our survival, but enriches our existence by describing features of what we see according to texture, color, context and depth. At a very simple level, the visual system consists of the eye and a long chain of neural connections to the brain.

The human eye is a fragile extension of the brain, encased and protected by the bones of the skull. It comprises of three coats. The cornea forms the clear and transparent front portion of the outer layer, through which light passes. The remaining outer layer is formed by the tough, white sclera that protects the delicate receptors within. The second or middle layer is called the uvea. It consists of the choroid and contains blood vessels that supply the eye with nutrients. The innermost layer contains the specialized receptor cells of the retina [1].

This extremely delicate organ can fall prey to different eye problems due to allergic factors, unhygienic conditions and old age. Pharmaceutical agents are used daily for patient evaluation, diagnosis and treatment. Many patients are also using other drugs to treat various medical conditions. Originally, physicians prepared their own pharmaceutical agents with certain plants and fruits, thereby, practicing traditional medicine. Today, most, if not all, pharmaceuticals are prepared commercially and have been used by eye care specialists and other health care providers [2]. Traditional medicine which is the old method of treatment of maladies remains preferred by many as regards to the toxic effect posed by the new pharmaceutical agent which comprises of compound chemical agents [3].

Various citrus species have been found useful as pharmaceutical, nutraceuticals, cosmetics and food supplement. Traditional uses of citrus have led to investigating their bioactive compounds, which have resulted in the detection of a significant number of therapeutic properties [4]. The citrus, lemon is a species of small evergreen tree in the flowering plant family, *Rutaceae*, native to Asia. The tree's ellipsoidal yellow fruit is used for culinary and non-culinary purposes, throughout the world, primarily for its juice which has both culinary and cleaning uses. The pulp

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and rind are used in cooking and baking. The juice of lemon is about 5% to 6% citric acid, providing 64% of the daily value in a 100 g serving. It gives a sour taste. The distinctive sour taste of lemon juice makes it a key ingredient in drinks and foods such as lemonade and lemon meringue pie [5].

According to Oguntola, et al. [6], previous studies have documented the use of citrus lemon in the management of febrile illnesses in Rivers state, Nigeria. Also according to study by Ajaiyeoba, et al. [7], published in West African Journal of Pharmacology and Drug Research, members of Kaani and Boue, in Rivers state identified lemon juice as one of the herbal medicines for the treatment of febrile illnesses. But still many remain unaware of the health benefits that this citrus fruit can provide. Due to its acclaimed medicinal effect, many people mow take it so well in different ways. Notable among the medicinal uses of lemon juice is in the treatment of urinary tract infection due to its detoxification properties, reduction of stress and depression, curing of throat related infections such as sore throat, oral ulcers, and tonsillitis [8].

Blood pressure

Sembulingam, et al. [9] defined arterial blood pressure as the lateral pressure exerted by the volume of blood on walls of arteries. This pressure is exerted when blood flows through the arteries. Blood pressure is usually expressed in terms of systolic blood pressure (maximum during one heart beat) over diastolic (minimum between two heart beats) and is measured in millimeters of mercury (mmHg), above the surrounding atmospheric pressure (considered to be zero for convenience). Raised blood pressure has proven to be a risk factor for many complications like heart attack, stroke and several vascular diseases of the eye such as hypertensive retinopathy.

Near point of convergence

The nearest point for which convergence is possible is called near point of convergence [10]. Convergence like accommodation is considered to have a far point (punctum remotum) and near point (punctum proximum). Punctum proximum is measured by determining the closest point to the patient along the primary sagittal line at which the eye can still continue to fixate on the target with both eyes. The distance from the spectacle plane at which diplopia occurs, or one eye deviates, can be converted into various units, indicating the punctum proximum of convergence.

If an object is gradually brought near to the eyes they can converge more and more upon it, but a point is reached when the limit of convergence is attained, the image doubles at this point giving up the sustained effort. The expected value of the near point of convergence found to be in the neighborhood of 12 cm-15 cm on repeatedly testing, the examiner should suspect the convergence insufficiency syndrome [11].

Near point of accommodation

This is the point in which accommodation is maximally exerted. The NPA is the nearest object point for which an image point is focused on the retina. It is also always located in front of the eye.

The test for near point of accommodation is similar to the test of near point of convergence if a target is moved slowly, or gradually, toward the eyes, they converge more and more upon it until a point is reached when the target blurs. This is usually called the first sustained blur in the clinic, now the distance from the target to the spectacle plane of the eyes gives the near point of accommodation. NPA varies with age of the patient in emmetropic or artificially emmetropic eyes. It is closest to the eye in the young and gradually recedes until the age of 45, when more rapid recession occurs [12].

Care should be given to make sure the near point card or target receives sufficient illumination as it approaches the patient's eyes. However, the illumination should not be so bright as to cause unnecessary constriction of the patient's pupil which will increase depth of focus and cause the near point of accommodation to be erroneously low.

Pupil size

This is the measurement of the physiological pupil diameter. The pupil is located in the centre of the iris of the eye that allows light to strike the retina [13]. It appears black because light rays entering the pupil are either absorbed by the tissues inside the eye directly, or absorbed after diffuse reflections within the eye that mostly miss exiting the narrow pupil.

Pupil size is controlled by smooth muscles innervated by the autonomic nervous system. An effective competition between the radial dilator muscle which is sympathetically innervated and acts to dilate the pupil and the annular sphincter muscle which is parasympathetically innervated and acts to constrict the pupil, determines the pupil size. The normal pupil size in adults varies from 2 mm-4 mm in diameter in bright light to 4 mm to 8 mm in the dark. The pupils are generally equal in size. They constrict to direct illumination (direct response). The pupil dilates in the dark. Both pupils constrict when the eye is focused on a near subject (accommodative response). The pupil is abnormal when it fails to constrict to light or accommodation or fails to dilate in the dark. The size of the pupils is measured under room illumination with a millimeter rule held against the patient's check bones and covering the lower half of the patient's pupils.

MATERIALS AND METHODS

Research design

This study was designed to be a prospective research comprising of human subjects who served as their own controls after informed consent was sought and obtained from each of them and from the ethical committee of the College of Medicine and Health Sciences Abia State University, Uturu.

The baseline blood pressure, near point of accommodation, near point of convergence and pupil size were taken prior to the administration of 30 ml of lemon extract. The induced blood pressure, near point of accommodation, near point of convergence and pupil size were measured and recorded 30 minutes, 1 hour 30 minutes and 2 hours subsequently post administration of lemon extract.

Research population

The study population comprised of 50 healthy young adults made up of 20 males and 30 females aged between 16-27 years.

Research locale

The study was carried out in the optometry clinic of Abia State University, Uturu. The location was chosen because of the availability of highly sophisticated research instruments, accompanied with high patient patronage.

Research instruments and materials

The instruments and materials used for the research includes fresh lemon, distilled water,plastic juice extractor, mercury sphygmomanometer, stop watch, pen light, direct ophthalmoscope

(Heine Beta), Pupillary Distance (PD) rule and grated measuring cup.

Preparation of lemon extract for consumption

Fresh lemon fruits were bought from Ariara international market in Aba, Abia State and were authenticated by a professor of Plant Science and Biotechnology Department of Abia State University, Uturu. The fruits were rinsed thoroughly with distill water, peeled, and were cut into halves. The juice was extracted from the fruits using a juice extractor. The fruit juices obtained were preserved at 40°C in air tight containers until subsequent use.

Research criteria

The volunteers were subjected to comprehensive screening exercise through a thorough extensive case history, external examination, and ocular health examinations in order to carefully select those deemed fit for the research. Subjects with the following conditions were exempted.

1. Subjects with visual acuity less than 6/6 at distance and N5 at near.
2. Subjects with any pathology of the ocular system.
3. Subjects with history of cardio-pulmonary disease since there is deranged blood pressure away from normalcy when the organs of the heart and lungs are diseased.
4. Subjects that are using any drug medication.
5. Subjects that presently have any other system diseases.

Data collection

The subjects that passed the screening tests were allowed to rest on a comfortable chair 30 minutes before the measurement of their Blood Pressure (BP) Near Point of Accommodation (NPA), Near Point of Convergence (NPC) and purple size. The baseline blood pressure and visual functions were measured and recorded prior to the administration of the lemon extract respectively using mercury sphygmomanometer, near PD rule and penlight.

The subjects were then orally administered 30 ml of lemon extract. Their blood pressure and the three visual functions were measured at 30 minutes, 1 hour, 1 hour 30 minutes and 2 hours subsequently and their readings noted and recorded. The study lasted for ten days as five subjects were used each day.

Data analysis

From the data collected, analysis was done using the SPSS software package. The Z-test was used to determine the level of significance of the values.

Precautions

1. Blood pressure, near point of accommodation, near part of convergence and pupil size measurements were properly monitored for the exact time interval designated for their measurement in all subjects.
2. The measurement of blood pressure and the three visual functions mentioned above was properly conducted in a hygienic environment.
3. Subjects were given the same quantity of extract.
4. The blood pressure measurements were taken thrice and the mean value was recorded to reduce errors.
5. The right targets were used for measuring the visual functions.

RESULTS AND DISCUSSION

This study was carried out on 50 subjects, 20 males and 30 females between areas 16 to 27 years with mean age of 21 ± 3.39 year. It shows the value of significance of lemon extract on blood pressure, NPC, NPA and pupil size. It was shown that blood pressure (systolic and diastolic) and the visual functions reduced at all time intervals of 30 minutes, 1 hour, 1 hour 30 minutes and increased towards baseline after 2 hours, post administration of lemon extract (30 ml).there was more significant reduction at 1 hour.

Table 1 demonstrated the mean ± SD values of 108.38 mmHg ± 7.45 mmHg, 97.74 mmHg ± 8.67 mmHg, 103.84 mmHg ± 8.63 mmHg and 110.86 mmHg ± 9.52 mmHg a time intervals of 30 minutes, 1 hour, 1 hour 30 minutes and 2 hours respectively for the systolic. While on the diastolic, induced mean values of 72.56 mmHg ± 5.29 mmHg, 65.82 mmHg ± 5.72mmHg, 68.90 mmHg ± 5.81 mmHg, and 73.46 mmHg ± 7.11 mmHg at all-time intervals of 30 minutes, 1 hour, 1 hour 30 minutes and 2 hours respectively (Table 1).

Table 1: Effect of lemon extract on blood pressure at baseline and time intervals of 30 minutes, 1 hour, 1 hour 30 minutes, and 2 hours after ingestion.

BP	Baseline	30 minutes	1 hour	1 hour 30 mins	2 hours
SBP	114.546.76	108.387.45	97.74	103.848.63	110.869.52
DBP	75.505.29	72.565.29	65.825.72	68.905.81	73.467.11

Note: BP: Blood Pressure; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure

Table 2 showed the mean decrease with percentage decrease in blood pressure from the baseline. There was 6.16 mmHg/2.94 mmHg (5.38/3.89)% decrease, 16.80 mmHg/9.68 mmHg (14.67/12.82)% decrease, 10.70 mmHg/6.60 mmHg (9.34/8.94)% decrease and 3.68 mmHg/2.04 mmHg (3.21/2.70)% decrease after 30 minutes, 1 hour, 1 hour 30 minutes and 2 hours (Table 2).

Table 2: Effect of lemon extract on near point of accommodation at baseline and time intervals of 30 mins, 1 hr, 1 hr 30 mins, and 2 hrs after ingestion with the corresponding mean decrease and % decrease.

Time intervals	Mean NPA	Mean decrease (Baseline NPA-NPA over time intervals)	% decrease
Baseline	8.130.94	-	-
30 minutes	7.650.70	0.48	5.9
1 hour	6.950.89	1.18	14.51
1 hr 30 mins	7.27	0.86	10.58
2 hours	7.700.79	0.43	5.29

Note: NPA: Near Point of Accommodation

Table 3 showed that there was reduction in the NPA, with its lowest point being at 1 hour with a mean ± SD of 6.95 cm ± 0.89 cm with the percentage decrease of 14.51% (Table 3).

Table 3: Effect of lemon extract on near point of convergence at baseline and time intervals of 30 mins, 1 hr, 1 hr 30 mins, and 2 hrs after ingestion with the corresponding mean decrease and % decrease.

Time intervals	Mean NPC	Mean decrease (Baseline NPC-NPC over time intervals)	% decrease
Baseline	8.170.96	-	-
30 minutes	7.771.00	0.40	4.90
1 hour	7.240.74	0.93	11.38

1 hr 30 mins	7.32	0.85	10.40
2 hours	7.840.79	0.33	4.04

Note: NPC: Near Point of Convergence

Table 4 showed that NPC reduced with its highest reduction value at 1 hour with mean value of 7.24 cm ± 0.74 cm with percentage decrease of 11.38% (Table 4).

Table 4: Effect of lemon extract on pupil size at baseline and time intervals of 30 mins, 1 hr, 1 hr 30 mins, and 2 hrs after ingestion with the corresponding mean decrease and % decrease.

Time intervals	Mean pupil size	Mean decrease (Baseline pupil size-pupil size over time intervals)	% decrease
Baseline	3.881.04	-	-
30 minutes	3.480.53	0.40	10.31
1 hour	2.770.29	1.11	28.61
1 hr 30 mins	2.95	0.93	23.97
2 hours	3.440.74	0.44	11.34

From the results, there was a decrease in pupil size from baseline values of mean ± SD 3.88 mm ± 1.04 mm to 3.48 ± 0.53 mm, 2.77 mm ± 0.29 mm, 2.95 mm ± 0.36 mm and 3.44 mm ± 0.74 mm, 30 minutes, 1 hour, 1 hour 30 minutes and two hours. It also showed that lemon extract 30 ml reduced the diastolic blood pressure of males more, while the systolic blood pressure of females was reduced more. NPA of females was at all time intervals greater than that of the males. The females had NPC and pupil size values, respectively and as a result their values were reduced at all times.

In a study done by Igwe, et al. [14] to evaluate the effects of hydrochloride, an anti-hypertensive drug on some visual functions which included pupil size and NPC. Results showed that pupil size decreased by 31% and NPC increased by 16%. The effect on pupil size was because of the para sympathomimetic effect of the drug.

According to Grosvenor [11], when there is constriction of pupil during NPA test, depth of focus increases causing near point of accommodation to be reduced. The result gotten from this research doesn't correspond with the study by Igwe, et al. [14] based on the significant decrease in NPC values. This could be due the variation on the phobia of the different subjects used and due to the phytochemicals/nutrients contained in lemon.

CONCLUSION

The effect of lemon extract on blood pressure is present and is statistically significant. The effect of lemon extract on systolic blood pressure is more significant in females. The effect of lemon extract on diastolic blood pressure is more significant in males. There is statistically significant reduction of NPA by lemon extract. There is statistically significant reduction of NPC by lemon extract. There is statistically significant reduction of pupil size by lemon extract.

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