EFFECT OF GRADED DOSES OF HIBISCUS SABDARIFFA AQUEOUS EXTRACT ON INTRAOCULAR PRESSURE AND BLOOD PRESSURE IN NORMOTENSIVES

BY

OSAYANDE AMEN OSAZUWA

LSC1806963

DEPARTMENT OF OPTOMETRY

FACULTY OF LIFE SCIENCES

UNIVERSITY OF BENIN

FEBRUARY, 2025

EFFECT OF GRADED DOSES OF HIBISCUS SABDARIFFA AQUEOUS EXTRACT ON INTRAOCULAR PRESSURE AND BLOOD PRESSURE IN NORMOTENSIVES

BY

OSAYANDE AMEN OSAZUWA

LSC1806963

A PROJECT SUBMITTED TO THE DEPARTMENT OF OPTOMETRY,

FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF DOCTOR OF OPTOMETRY DEGREE (OD).

FEBRUARY, 2025

CERTIFICATION AND APPROVAL

DEDICATION

This project is dedicated to God Almighty for his faithfulness, his grace and mercy. It is also dedicated to my family for their love and support.

ACKNOWLEDGEMENT

I OSAYANDE AMEN OSAZUWA wish to attribute this work to GOD ALMIGHTY, who has given me strength and knowledge to complete this research, so I dedicate this project to him for his exceeding grace and mercy.

I sincerely appreciate all efforts and inputs rendered unto me by my project supervisor PROF. (MRS). G.O. GEORGE, whose valuable support cooperation guidelines and suggestions from time to time ensuring the successful completion of this project work. I am really thankful to you ma, for all your academic criticism and correction all through this project. Also, my sincere appreciation to all the lecturers and staff of the optometry department, it is with your helpful contribution towards my academic pursuit that brought me to achieving my goals.

I also want to appreciate my parents, Chief Osayande Amadin Osazuwa and Mrs Blessing Osayande, and my siblings, Mr osaige Osayande, Mrs joy Osayande, Mrs Iyore Osayande ,Engineer Emmanuel Osayande, Mrs gloria Osayande , Barrister eric Osayande, Mr Edosa Odeh, and the Ewaen family for their undying love and support towards me throughout this program (DOCTOR OF OPTOMETRY) and to Briella eye care clinic and their staffs, Dr Uwa, Dr Ozioma and Dr Enock, to all my colleagues and my friends, Kingsley, Philip, Juliet, Ruth, Sherifat, Marvelous,Chisom,Chiamaka,Peter,Osama,Deborah,Clemeas,David,Uka,Abel,Princess,Halima, Dr Fortune, Dr Franklyn, Dr Silver, Dr Nathaniel, Dr Anslem, Dr Olubor and special thanks to the Adventist Student Fellowship and the Seventh Day Adventist Church for their immense contribution.

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

This study aimed to investigate the effects of graded doses of Hibiscus Sabdariffa aqueous extract on intraocular pressure (IOP) and blood pressure (BP) in normotensive individuals. A total of 40 university students (22 males, 18 females) aged 18-29 years (mean age: 24.3 ± 3.20 years) participated in this study. The participants were divided into four groups: three experimental groups (A, B, C) and a control group (D), each consisting of 10 normotensive subjects. Baseline IOP and BP measurements were obtained using an iCare TA01i Tonometer and a HEM-7124 blood pressure monitor, respectively. The experimental groups received graded doses of Hibiscus Sabdariffa aqueous extract, and IOP and BP measurements were taken at 30-, 60-, 90-, and 120-minutes post-ingestion. The results showed a significant decrease in IOP in the left eye, with a statistically significant effect observed ($p < 0.05$), and the most substantial reduction occurred at 120 minutes post-ingestion. Additionally, the effect of Hibiscus Sabdariffa on BP was found to be dose-dependent, with a statistically significant effect observed ($p < 0.05$). This study recommends that potential integration of Hibiscus sabdariffa leaf aqueous extract as a complementary therapy in the management of certain ocular conditions warrants further consideration. However, additional research is needed to fully elucidate its therapeutic potential and safety profile

Keywords: *Hibiscus Sabdariffa, Intraocular pressure, Blood pressure and Normotensives.*

CHAPTER ONE

1.0 INTRODUCTION

Hibiscus sabdariffa, also called Roselle or Zobo, has significant cultural and medicinal value. It is a flowering shrub native to tropical areas in Africa and Asia, belonging to the *Malvaceae* family (Riaz and Chopra, 2018; Nwaiwu *et al*., 2020). Out of over 300 species in the *Malvaceae* family, its leaves are important in traditional medicine and cuisine in several countries, including Nigeria, Mexico, and Thailand (Akujobi *et al*., 2018). The drink made from its dried calyxes, known as Zobo, is a vital part of dietary traditions in various regions. This bright red beverage is not only favored for its refreshing taste but has also garnered scientific attention due to its rich phytochemical content. It is recognized for its high levels of antioxidants, flavonoids, and phenolic compounds, which are thought to provide potential health benefits (Ojulari *et al*., 2019).

The intricate balance of intraocular pressure (IOP) plays a pivotal role in maintaining ocular health, influencing both the structure and function of the eye. Deviations from this balance, particularly elevated IOP, have consistently emerged as a significant risk factor for various ocular pathologies, notably glaucoma, a leading cause of irreversible blindness globally (Weinreb *et al.,* 2014). Regulating IOP involves delicate mechanisms that govern the equilibrium between the production and drainage of aqueous humor. As the prevalence of ocular disorders rises, eye care practitioners face challenges, compelling the exploration of alternative approaches to conventional treatments.

Hypertension has been considered as a risk factor of various diseases including ischemic heart and cerebrovascular disease as well as chronic kidney disease. Hypertension also accounts for increases in disability-adjusted life years and deaths worldwide. The global prevalence of

hypertension among adults was 31.1% and its burden was higher in low- and middle-income countries. In addition, 26.6% of the population of Iran are hypertensive. It should be noted that in developing countries, insufficient treatment and unawareness, make the management of hypertensive individuals more challenging for healthcare systems.

Good blood pressure control can prevent adverse cardiologic outcome including heart attacks and heart failures. There are different classes of antihypertensive drugs such as thiazides, beta-blockers, calcium channel blockers, angiotensin II receptor blockers, and alpha-blockers which are used clinically to treat hypertension. According to these facts, this study aimed to evaluate the effect of Hibiscus sabdariffa on intraocular pressure and blood pressure in normotensive subjects.

1.1 BACKGROUND

Intraocular pressure (IOP) is the pressure exerted by the fluid inside the eye, which is essential for maintaining the eye's shape and function. Increased IOP is a major risk factor for glaucoma, a leading cause of blindness globally. Various factors, including age, race, and systemic health issues such as hypertension and diabetes, can influence IOP.

Research has indicated that both environmental and physiological elements can affect IOP. For example, studies have found that physical activity can cause temporary changes in IOP, while prolonged positions, like lying down, may lead to increased pressure. Additionally, medications that alter fluid dynamics in the eye can significantly impact IOP management.

Regular IOP monitoring is crucial for those at risk of glaucoma, with techniques such as tonometry being commonly used for accurate measurement. Understanding the connection between IOP and systemic conditions, including blood pressure, is vital for creating effective

treatment plans and preventing vision impairment (Klein *et al*., 2018). In conclusion, intraocular pressure is a critical component of eye health, and ongoing research is essential to uncover its complexities and significance in conditions like glaucoma.

CAUSES AND RISK FACTORS OF INCREASED INTRAOCULAR PRESSURE (IOP)

1. FLUID IMBALANCE

An imbalance in the production and drainage of aqueous humor is a primary cause of elevated intraocular pressure (IOP). Aqueous humor is the clear fluid produced by the ciliary body in the eye, and it nourishes the lens and cornea. When the production of aqueous humor exceeds its drainage, the pressure inside the eye increases. Conditions like angle-closure glaucoma can obstruct the drainage pathways, leading to elevated IOP (American Academy of Ophthalmology, 2022).

2. AGE

Age is a significant risk factor for elevated IOP. As people age, the eye's drainage system becomes less efficient, leading to increased pressure. According to the American Academy of Ophthalmology, the risk of developing glaucoma increases significantly after the age of 40. A study published in the Journal of Glaucoma found that the incidence of glaucoma increased with age, with the highest incidence occurring in individuals aged 70-79 years (Klein *et al*., 2013).

3. GENETIC FACTORS

Genetic factors play a crucial role in the development of elevated IOP. A family history of glaucoma or high IOP can increase an individual's risk. Certain genetic traits can affect the structure and function of the eye, leading to elevated IOP (National Eye Institute, 2022).

Research suggests that genetic mutations in the MYOC gene are associated with primary open-angle glaucoma.

4. ETHNICITY

Ethnicity is another factor that contributes to elevated IOP. Certain racial groups, especially those of African descent, are more prone to elevated IOP and glaucoma. According to the National Eye Institute, African Americans are six to eight times more likely to develop glaucoma than Caucasians (National Eye Institute, 2022). A study published in the American Journal of Ophthalmology found that African Americans had a higher incidence of glaucoma than Caucasians.

5. HEALTH CONDITIONS

Systemic diseases like hypertension and diabetes can influence IOP by affecting blood flow and fluid dynamics in the eye. Research suggests that people with hypertension are more likely to develop glaucoma (Klein *et al*., 2013). Similarly, diabetes can increase the risk of glaucoma by damaging the blood vessels in the eye (American Diabetes Association, 2022).

6. MEDICATIONS

Long-term use of corticosteroids and other medications can lead to increased IOP by impacting the drainage of aqueous humor. Corticosteroids can increase the production of aqueous humor, leading to elevated IOP. A study published in the Journal of Ophthalmology found that long-term use of corticosteroids increased the risk of glaucoma.

7. EYE TRAUMA OR SURGERY

Injuries to the eye or previous surgical procedures can alter the eye's structure, affecting its ability to regulate pressure. Trauma to the eye can cause bleeding or inflammation, leading to increased IOP (American Academy of Ophthalmology, 2022). A study published in the Journal of Trauma and Acute Care Surgery found that eye trauma increased the risk of glaucoma.

8. ENVIRONMENTAL INFLUENCES

Factors such as prolonged eye strain, stress, and lack of exercise may contribute to temporary increases in IOP. Research suggests that prolonged near work, such as reading or computer use, can increase IOP. A study published in the Journal of Ophthalmology found that stress increased the risk of glaucoma.

9. OBESITY

Being overweight can be linked to higher IOP, possibly due to changes in circulation and eye anatomy. Research suggests that obesity is a risk factor for glaucoma, although the exact mechanisms are unclear. A study published in the Journal of Glaucoma found that obesity increased the risk of glaucoma (Klein *et al*., 2013).

Recognizing these causes and risk factors is crucial for monitoring and managing IOP, especially for those at risk of glaucoma. Regular eye check-ups can help detect any changes early on.

1.1.1 GLAUCOMA

Glaucoma is one of the major risk factors of increased intraocular pressure, it is commonly known as the "silent thief of sight". Glaucoma is a group of eye conditions that damage the optic

nerve, often due to increased pressure in the eye (intraocular pressure). It's a leading cause of blindness, especially in older adults.

CAUSES AND RISK FACTORS OF GLAUCOMA

1. INCREASED INTRAOCULAR PRESSURE (IOP)

Increased IOP is the most common cause of glaucoma. The fluid in the eye, known as aqueous humor, is produced by the ciliary body and drains through the trabecular meshwork. When the aqueous humor does not drain properly, it can lead to a buildup of pressure in the eye (American Academy of Ophthalmology, 2022). This increased pressure can damage the optic nerve, leading to vision loss.

2. GENETICS

A family history of glaucoma increases the risk of developing the condition. Research suggests that genetic mutations can affect the trabecular meshwork, leading to increased IOP (National Eye Institute, 2022). A study published in the Journal of Glaucoma found that individuals with a family history of glaucoma were more likely to develop the condition (Klein *et al*., 2013).

3. AGE

The risk of developing glaucoma increases with age, particularly after age 60. According to the American Academy of Ophthalmology, the prevalence of glaucoma increases significantly after age 60 (American Academy of Ophthalmology, 2022). A study published in the Journal of the American Geriatrics Society found that the risk of glaucoma increased with age, with the highest risk occurring in individuals aged 80 and older.

4. MEDICAL CONDITIONS

Certain medical conditions can increase the risk of developing glaucoma. These conditions include:

- Diabetes: Research suggests that individuals with diabetes are more likely to develop glaucoma.
- Hypertension: High blood pressure can increase the risk of glaucoma by damaging the blood vessels in the eye (Klein *et al*., 2013).
- Eye diseases: Certain eye diseases, such as cataracts and age-related macular degeneration, can increase the risk of developing glaucoma.

5. EYE INJURIES

Trauma to the eye can lead to secondary glaucoma. Eye injuries can cause bleeding or inflammation in the eye, leading to increased IOP (American Academy of Ophthalmology, 2022). A study published in the Journal of Trauma and Acute Care Surgery found that eye trauma increased the risk of glaucoma.

6. CORTICOSTEROID USE

Long-term use of corticosteroids can increase the risk of developing glaucoma. Corticosteroids can increase the production of aqueous humor, leading to increased IOP (Bartlett *et al*., 2013). A study published in the Journal of Ophthalmology found that long-term use of corticosteroids increased the risk of glaucoma (Sauder *et al*., 2013).

TYPES OF GLAUCOMA:

1. OPEN-ANGLE GLAUCOMA: A SILENT THIEF OF SIGHT

Open-angle glaucoma is the most common type, accounting for 90% of all glaucoma cases. It occurs when the trabecular meshwork, responsible for draining the aqueous humor, becomes clogged or damaged. This leads to increased eye pressure, causing vision loss without noticeable symptoms in the early stages.

2. ANGLE-CLOSURE GLAUCOMA: A MEDICAL EMERGENCY

Angle-closure glaucoma is a less common type that occurs when the iris blocks the drainage angle, causing a sudden increase in eye pressure. This leads to severe eye pain, blurred vision, and nausea. It's a medical emergency requiring immediate treatment to prevent permanent vision loss.

3. NORMAL-TENSION GLAUCOMA: DAMAGE DESPITE NORMAL PRESSURE

Normal-tension glaucoma occurs when the optic nerve is damaged despite normal eye pressure. The causes are not fully understood, but it's believed to be related to reduced blood flow, fragile optic nerve tissue, or underlying medical conditions.

4. SECONDARY GLAUCOMA: CAUSED BY OTHER CONDITIONS

Secondary glaucoma is caused by other medical conditions or medications. It can occur due to eye injuries, inflammation, certain medications, medical conditions like diabetes or hypertension, or eye tumors. Treatment depends on the underlying cause. Understanding these different types of glaucoma is crucial for developing effective treatment strategies and preventing vision loss.

TREATMENT PLAN:

1. **MEDICATIONS**:

- Prostaglandin analogs: Increase the outflow of fluid from the eye.
- Beta-blockers: Decrease fluid production.
- Alpha agonists: Reduce fluid production and increase outflow.
- Carbonic anhydrase inhibitors: Decrease fluid production.

2. **LASER TREATMENT**:

- Laser trabeculoplasty: Helps drain fluid from the eye.
- Laser iridotomy: Creates a new drainage hole in the peripheral iris for angle-closure glaucoma.

3. **SURGERY**:

- Trabeculectomy: Creates a new drainage pathway for fluid.
- Tube shunt surgery: Places a small tube to help drain fluid.
- Regular Monitoring: Regular eye exams are essential for monitoring intraocular pressure and optic nerve health.

1.1.2 BLOOD PRESSURE

Blood pressure (BP) refers to the force that circulating blood exerts on the walls of blood vessels. It is presented as two figures: systolic pressure (during heartbeats) and diastolic pressure (between heartbeats). Maintaining normal blood pressure is essential for ensuring proper blood

flow to organs and tissues. Hypertension, which is diagnosed when blood pressure readings are consistently at or above 140/90 mmHg, significantly increases the risk of heart diseases, strokes, and kidney issues.

1.1.3 HYPERTENSION

Hypertension is the most common condition which is caused by increased blood pressure. The World Health Organization (WHO, 2013) defined hypertension as a chronic condition that is characterized by a continual rise in the pressure at which blood flows in the blood vessels, which makes it hard for the heart to pump blood into the circulation. Diagnosis of hypertension is established when an individual has systolic blood pressure (SBP) of ≥ 130mmHg and diastolic blood pressure (DBP) of ≥80mmHg, this is in accordance with the guidelines formulated by the American Heart Association (AHA). (Whelton *et al*., 2018). High blood pressure is one of the leading risk factors that contribute to a high prevalence of cardiovascular diseases (CVDs) worldwide. Cardiovascular diseases encompass several groups of other heart diseases such as ischemic heart disease (IHD), coronary artery disease (CAD), congestive heart failure, cerebrovascular disease, and myocardial infarction (MI) (Mendis *et al*., 2011). Uncontrolled high blood pressure has also been attributed to be the leading cause of chronic renal failure in most of the countries with a high prevalence of hypertension (Pierdomenico *et al*., 2009). Implementing lifestyle changes, such as dietary intervention with conventional therapy, can help delay or mitigates increases in blood pressure, thereby decreasing the risk of developing CVD and organ damage associated with poorly controlled high blood pressure.

RISK FACTORS OF HYPERTENSION

Hypertension, or high blood pressure, is a complex condition influenced by a combination of genetic, lifestyle, and environmental factors. According to the American Heart Association (AHA), hypertension affects approximately 47% of adults in the United States (American Heart Association, 2022). Five key elements contribute to the development of hypertension:

1. GENETIC PREDISPOSITION

A family history of hypertension can significantly increase an individual's risk of developing the condition. Research suggests that genetic mutations affecting blood pressure regulation can be inherited, making certain populations more susceptible (Ehret & Caulfield, 2013). A study published in the journal Hypertension found that individuals with a family history of hypertension were more likely to develop the condition (Kupper *et al*., 2013).

2. AGE-RELATED CHANGES

As people age, their blood vessels become less flexible, and their kidneys' ability to regulate fluid balance and blood pressure decreases. This natural aging process increases the risk of developing hypertension. According to the Centers for Disease Control and Prevention (CDC), the prevalence of hypertension increases with age, affecting approximately 70% of adults aged 60 and older (Centers for Disease Control and Prevention, 2022).

3. LIFESTYLE FACTORS

Unhealthy lifestyle choices can substantially contribute to hypertension. These modifiable risk factors include:

- Consuming a high-sodium diet
- Leading a sedentary lifestyle
- Being obese or overweight
- Engaging in excessive alcohol consumption

A study published in the Journal of the American College of Cardiology found that lifestyle modifications, such as regular exercise and a balanced diet, can significantly reduce blood pressure levels (Eckel *et al*., 2014).

4. **UNDERLYING HEALTH CONDITIONS**

Certain chronic health conditions can increase the risk of developing hypertension. These conditions include:

- Diabetes
- Kidney disease
- Sleep apnea

A study published in the journal Diabetes Care found that individuals with diabetes were more likely to develop hypertension (Cheung *et al*., 2013).

5. **CHRONIC STRESS**

Prolonged stress can cause temporary blood pressure spikes, which can eventually lead to hypertension. Unhealthy coping mechanisms can further exacerbate this issue. Research suggests that stress management techniques, such as meditation and yoga, can help reduce blood pressure levels (Abbot *et al*., 2014).

In conclusion, hypertension is a complex condition influenced by a combination of genetic, lifestyle, and environmental factors. By understanding these contributing elements, individuals can take proactive steps to reduce their risk of developing hypertension and promote overall cardiovascular health.

MEASUREMENT METHODS

Blood pressure is typically assessed using a sphygmomanometer, with measurements taken while the patient is at rest. Accurate readings are crucial for diagnosing hypertension. Methods such as home monitoring and ambulatory blood pressure monitoring are also recommended for more thorough evaluations.

TREATMENT OPTIONS

Managing high blood pressure involves lifestyle changes and medication:

1. **LIFESTYLE CHANGES**: This includes adhering to a balanced diet (like the DASH diet), engaging in regular exercise, managing weight, and reducing sodium consumption.

2. **MEDICATIONS**: Common antihypertensive medications include diuretics, ACE inhibitors, calcium channel blockers, and beta-blockers. The choice of medication often depends on the individual's overall health and any additional medical conditions.

1.2 STATEMENT OF PROBLEM

Raised intraocular pressure remains the major risk factor for glaucoma which can be altered. Determining the effects of graded doses of *Hibiscus Sabdariffa* aqueous extract may help to discover the dosage that has a significant IOP lowering effect which may serve as an adjunct therapy for management of ocular hypertension and glaucoma. This will also enhance clinician's

knowledge as well help in educating the patients, especially glaucoma and hypertensive one, on the possible health benefit from their use.

1.3 AIM

The aim of this study is to investigate the effects of graded doses of *Hibiscus Sabdariffa* aqueous extract on intraocular pressure and blood pressure

1.3.1 OBJECTIVE OF STUDY

1. To determine the doses of *Hibiscus sabdariffa* extract which has significant effect on intraocular pressure and blood pressure
2. To determine if the effect of graded doses of *Hibiscus sabdariffa* extract on intraocular pressure and blood pressure is dose dependent.

1.4 SIGNIFICANCE OF STUDY

1. The research will inform eye care professionals of the effect of *Hibiscus Sabdariffa* on intraocular pressure and systemic blood pressure.
2. This study is expected to enhance the existing literature on herbal remedies, specifically regarding their role in ocular and cardiovascular health.
3. This will enable optometrists to educate patients especially those with glaucoma and hypertension, on the health benefits of *Hibiscus Sabdariffa* extracts.

1.5 DEFINITION OF TERMS

1. **HIBISCUS SABDARIFFA**: Hibiscus sabdariffa, also known as roselle or sorrel, is a tropical plant species belonging to the family Malvaceae. It is an annual or perennial herb native to Africa and Asia, widely cultivated for its edible calyces, leaves, and seeds.
2. **INTRAOCULAR PRESSURE(IOP)**: The pressure exerted by the fluids in the eyeball, specifically the aqueous humor, against the cornea and sclera. IOP is measured in millimeters of mercury (mmHg) using a tonometer. A normal IOP ranges from 10-21 mmHg. Maintaining a healthy IOP is crucial for preventing and managing glaucoma, a group of eye conditions that can lead to vision loss and blindness if left untreated.
3. **BLOOD PRESSURE**: Blood pressure (BP) is the pressure exerted by blood upon the vessel walls as it circulates throughout the body. It is a critical vital sign that reflects the force of blood pushing against the arterial walls.normal blood pressure ranges from systolic blood pressure of 120mmhg and diastolic blood pressure of 80mmhg. Blood pressure plays a crucial role in maintaining tissue perfusion and oxygenation. Abnormal blood pressure values can indicate various cardiovascular and renal disorders, making accurate measurement and interpretation essential in clinical practice.
4. **GRADED DOSES**: Graded doses refer to a series of incrementally increasing or decreasing amounts of a substance, such as a medication, toxin, or stimulus, administered to a subject or system in a controlled and sequential manner. Graded doses can be used in various fields like, Pharmacology,Toxicology,Clinical trials and

Research. In this study graded doses of 3.57g/kg,4.28g/kg and 7.14g/kg body weight was used.

5. **AQUEOUS EXTRACT**: An aqueous extract is a liquid solution obtained by extracting bioactive compounds from plant or animal materials using water as the solvent.
6. **NORMOTENSIVES**: Normotensives are individuals characterized by a normal blood pressure reading, specifically a systolic blood pressure (SBP) below 120 mmHg and a diastolic blood pressure (DBP) below 80 mmHg.
7. **GLAUCOMA**: Glaucoma is a cluster of chronic, degenerative optic neuropathies marked by irreversible optic nerve damage, frequently asymptomatic in the early stages, and progressing to peripheral visual field defects, potentially culminating in blindness. Elevated intraocular pressure is a major risk factor, although normal tension glaucoma can occur.
8. **HYPERTENSION**: Hypertension, or high blood pressure, is a chronic condition marked by consistently elevated arterial blood pressure levels, specifically systolic blood pressure (SBP) of 130 mmHg or higher and/or diastolic blood pressure (DBP) of 80 mmHg or higher.
9. **CONTROL GROUP**: A control group is a subset of participants in a research study who do not receive the experimental treatment or intervention being tested. Instead, they receive a placebo, standard treatment, or no treatment at all, serving as a baseline or reference group for comparison with the experimental group.

10. **PLACEBO**: A placebo is a simulated or inactive treatment, intervention, or substance that is designed to mimic the appearance, taste, and feel of an actual treatment, but lacks any therapeutic or pharmacological effect, used as a control in research studies to isolate and measure the actual treatment's efficacy. In this study water was used as a placebo.

CHAPTER TWO

2.0 LITERATURE REVIEW

Faraji *et al*., (1999) investigated the effects of *Hibiscus sabdariffa* tea on blood pressure. The research was motivated by the traditional use of *Hibiscus sabdariffa* in various cultures for its potential health benefits, particularly in managing hypertension.

In the discussion section of the study, they highlighted that *Hibiscus sabdariffa* tea contains bioactive compounds, such as anthocyanins and flavonoids, which are known to have antioxidant properties. These compounds may contribute to vasodilation, thereby lowering blood pressure. The study found significant reductions in both systolic and diastolic blood pressure among participants who consumed the tea regularly compared to those who did not.

They conducted a randomized controlled trial involving participants with elevated blood pressure. They divided the participants into two groups: one group consumed *Hibiscus Sabdariffa* tea daily, while the control group did not receive the tea.

In conclusion, the study concluded that regular consumption of *Hibiscus sabdariffa* tea may significantly lower blood pressure, making it a potential adjunct therapy for hypertension.

The research conducted by Ngamjarus *et al*. (2018) examined how *Hibiscus sabdariffa* affects intraocular pressure (IOP) and blood pressure. In the discussion section, the authors highlighted the potential of *Hibiscus sabdariffa* as a natural treatment option due to its abundance of antioxidants and polyphenols. They suggested that these compounds might help reduce oxidative stress, which is associated with high IOP and hypertension.

Their study found that participants who consumed *Hibiscus Sabdariffa* experienced a notable reduction in both intraocular pressure and blood pressure compared to those in the control group.

As for the methods, the researchers carried out a randomized controlled trial with participants who had elevated blood pressure and IOP. They split the participants into two groups: one group received *Hibiscus sabdariffa* extract, while the other group received a placebo. Measurements of intraocular pressure and blood pressure were taken at the beginning and after the treatment period. The study also considered factors such as age, gender, and lifestyle to ensure the accuracy of the results.

In conclusion, the authors recommended *Hibiscus Sabdariffa* as a natural treatment option for lowering IOP and blood pressure due to its abundance of antioxidants and polyphenols.

The study by Okwu *et al*., (2016) investigated the combined effects of *Hibiscus sabdariffa* and other herbal remedies on hypertension and ocular health. In the discussion section, the authors emphasized the growing interest in alternative medicine, particularly in the use of herbal remedies for managing health conditions like hypertension and improving eye health. They highlighted that *Hibiscus sabdariffa* is known for its antihypertensive properties, and when combined with other herbs, it may enhance the therapeutic effects on blood pressure and ocular health.

For the methods, Okwu *et al*., conducted a systematic review of existing literature on the effects of *Hibiscus sabdariffa* and other herbal remedies on hypertension and ocular health. They included randomized controlled trials, observational studies, and clinical trials in their analysis. The authors evaluated the quality of the studies included and synthesized the findings to draw conclusions about the effectiveness of these herbal combinations.

They also considered factors such as dosage, duration of treatment, and the specific herbal combinations used in the studies. The review aimed to provide a comprehensive overview of how these herbal remedies can be utilized together to manage hypertension and support ocular health.

They concluded that *Hibiscus Sabdariffa* is known for its antihypertensive properties, and when combined with other herbs, it may enhance the therapeutic effects on blood pressure and ocular health.

Akinmoladun *et al*., (2018) carried out a study to explore how *Hibiscus sabdariffa* affects intraocular pressure (IOP) in rabbits. In their discussion, they highlighted the importance of their findings regarding the potential use of *Hibiscus sabdariffa* as a natural remedy for conditions linked to high IOP, such as glaucoma.

The authors observed a notable decrease in IOP in the rabbits treated with *Hibiscus sabdariffa* extract compared to those in the control group. They believed this effect was due to the bioactive compounds found in *Hibiscus sabdariffa*, especially antioxidants and flavonoids, which are recognized for their protective properties on eye health. The discussion pointed out that these compounds might help lower oxidative stress and inflammation, both of which can lead to increased IOP.

In conclusion, Akinmoladun *et al*., (2018) provided strong evidence that *Hibiscus sabdariffa* may positively influence reducing intraocular pressure in rabbits, suggesting its potential role in managing eye health.

Khamis *et al*., (2019) studied the effects of *Hibiscus sabdariffa* on intraocular pressure (IOP) in diabetic rats. They found that the extract significantly reduced IOP compared to the control

group. The authors linked this reduction to the antioxidants in *Hibiscus sabdariffa*, which may reduce oxidative stress common in diabetes. They suggested that the extract could enhance the outflow of aqueous humor and decrease its production, lowering eye pressure. The study indicates that *Hibiscus sabdariffa* could be a beneficial natural treatment for managing IOP, especially in diabetic patients, but further research is needed to confirm its long-term effects and safety.

Shafiee *et al.,* (2021) investigated the effect of *Hibiscus sabdariffa* consumption compared to other herbal teas and antihypertension drugs on systolic blood pressure (SBP) and diastolic blood pressure (DBP), Low-Density Lipoprotein Cholesterol(LDL-C), High-Density Lipoprotein Cholesterol(HDL-C), Total cholesterol(TC), Triglycerides(TG), fasting blood sugar(FBS), Body weight (BW) and Body mass index(BMI) as cardiometabolic risk factors. The results indicated that Hibiscus sabdariffa consumption when compared to the placebo or other tea could efficiently reduce SBP and DBP levels, but the changes in lipid profiles, FBS, BMI and BW are cardiometabolic.

McKay *et al.,* (2007) studied the bioactivity and potential health benefits of *Hibiscus sabdariffa* and in the study it was concluded that *Hibiscus's* overall health benefits has the potential for reducing oxidative stress, hypertension and systemic inflammation, which may indirectly benefit ocular health.

Abubakar *et al.,* (2019) studied Acute Effects of *Hibiscus sabdariffa* Calyces on Postprandial Blood Pressure, Vascular Function, Blood Lipids, Biomarkers of Insulin Resistance and Inflammation in Humans and he concluded that the extract of *Hibiscus sabdariffa* improved

postprandial vascular function and may be a useful dietary strategy to reduce endothelial dysfunction and cardiovascular risk, although this requires confirmation.

Shittu *et al*., (2020) investigated the effects of *Hibiscus sabdariffa* and Oolong tea on blood pressure and arterial stiffness in healthy adults. The results showed that the six weeks tea intervention had a significant positive impact on systolic blood pressure, diastolic blood pressure, and heart rate.

Adebiyi *et al*., (2013) in his study, antihypertensive effect of *Hibiscus Sabdarriffa's* linn.in humans revealed that those who drank *Hibiscus sabdariffa* tea had a significant decrease in both systolic and diastolic blood pressure compared to those in the control group. The researchers that this antihypertensive effect might be due to the presence of bioactive compounds like anthocyanins and flavonoids, which have the ability to dilate blood vessels.

Ogunleye *et al.,* (2017) study the effect of *Hibiscus Sabdariffa* on intraocular pressure in experimental glaucoma (2017) found that *Hibiscus sabdariffa* extract may lower intraocular pressure in animal models. The authors proposed that the antioxidant properties of the extract could help protect retinal cells and enhance eye health.

Bafakeeh *et al*., (2018) explored the impact of *Hibiscus sabdariffa* on lipid profiles in patients with metabolic syndrome. The study found that participants who consumed *Hibiscus sabdariffa* experienced not only reduced blood pressure but also improved lipid profiles, including lower levels of total cholesterol and triglycerides. This suggests that *Hibiscus sabdariffa* may have a multifaceted role in cardiovascular health.

Vasudevan *et al*., (2016) highlighted the antioxidant properties of *Hibiscus sabdariffa*, which may contribute to its ability to lower blood pressure and protect against oxidative stress. The

study demonstrated that the polyphenolic compounds in *Hibiscus sabdariffa* have strong antioxidant activity, which could help mitigate the risk factors associated with hypertension and other cardiovascular diseases.

Mohan *et al*., (2014) investigated the antihypertensive effects of *Hibiscus sabdariffa* in patients with prehypertension and mild hypertension. The results indicated that daily consumption of *Hibiscus sabdariffa* tea for six weeks led to a significant reduction in both systolic and diastolic blood pressure. The authors concluded that *Hibiscus sabdariffa* could be recommended as a natural remedy for managing hypertension.

Salami *et al*., (2020) studied assessment of antimicrobial activities and toxicological effects of green and red cultivars of roselle- *Hibiscus Sabdariffa* L the results showed that, Roselle extracts possessed excellent antibacterial and antifungal properties. These can be explored to develop new drugs, which can suppress the resistant strains. All the plant extracts were greater than 1000 mg/ml, which indicates that they were non-toxic to brine shrimp larvae.

Himanshu *et al*., (2021) in his study *Hibiscus Sabdariffa* Linn with their medicinal uses and pharmacological activity suggested many pharmacological properties of *Hibiscus Sabdariffa* may be attributed to a plethora of phytochemicals in the plant. The potent antioxidant activity of *Hibiscus Sabdariffa* may be linked to the presence of different antioxidants compounds with different sites and mechanisms of action, which may act alone or in concert with one another. Therefore, dietary supplementation of hibiscus sabdariffa plant extract may be beneficial in reducing the risk of developing various pathological conditions such as cardiovascular disease, cancer, neurological disorders and diabetes.

Hopkins *et al*., (2013) studied hibiscus sabdariffa Linn in the treatment of hypertension and hyperlipidemia stated that daily consumption of hibiscus sabdariffa tea or extracts had favorable influence on lipid profiles including reduced total cholesterol, LDL-C, triglycerides, as well increased HDL-C. Anthocyanins found in abundance in hibiscus sabdariffa calyxes are generally considered the phytochemicals responsible for the antihypertensive and hypocholesterolemia effects.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY DESIGN

To investigate the impact of Hibiscus sabdariffa aqueous extract on blood pressure and intraocular pressure, an experimental design was utilized, featuring graded doses and a control group. Participants were randomly divided into four groups, receiving varying doses of the extract or a control substance. This approach enabled a systematic examination of physiological responses, yielding reliable data on the extract's effects**.**

3.2 STUDY LOCATION

This study was conducted in the Optometry Clinic of the university of Benin, Benin City, due to the availability of the materials needed for this study.

3.3 STUDY DURATION

This study was completed over a period of one month.

3.4 STUDY POPULATION

This study included normotensives participants that were aged between 18 and 40 years. Participants used were university of Benin students who satisfy the inclusion criteria.

3.5 SAMPLE SIZE

The sample size was calculated using the Fischer Formula

$$n = \frac{Z^2 \times P(1-P)}{d^2}$$

Where n = sample size

Z= Statistical level of confidence of 95% (1.96)

P= maximum reported prevalence of 2.4% (According to Jo Suherman *et al*., 2010)

d= confidence interval (margin of error) 5% (d= 0.05)

where:

z =1.96

p= 0.024

d= 0.05

input the values using this formula

$$n = \frac{Z^2 \times P(1-P)}{d^2}$$

n= 1.96^ 2 × 0.024 (1- 0.024) / 0.05^2

n= 0.090/ 0.0025

n= 36

Attrition factor is 10% of n

Which is 3.6~ 4

36 4 = 40. Therefore 40 participants were used for this study.

3.6 SAMPLING TECHNIQUE

This study utilized convenience sampling, a non-probability method, to recruit participants from the University of Benin community who met specific inclusion criteria. Due to time and resource constraints, this approach was deemed most feasible, allowing for efficient participant recruitment with minimal logistical complexities.

3.7 RESEARCH MATERIALS

1. iCare TA01i Tonometer
2. HEM-7124 blood pressure monitor
3. Keeler Ophthalmoscope
4. Body weight scale
5. Penlight
6. *Hibiscus Sabdariffa* aqueous extract
7. Materials for recording of data
8. Measuring cup
9. Stop watch
10. Pure Water

3.8 INCLUSION CRITERIA

1. Individuals who fall within the age range of 18-40 years.
2. Non-hypertensive healthy individuals.
3. Individuals with normal intraocular pressure and without ocular pathology.
4. Individuals willing to participate in this study

3.9 EXCLUSION CRITERIA

1) Individuals whose age range is less than 18years or greater than 40 years.
2) Individuals with elevated blood pressure and raised IOP.
3) Individuals taking medications that could affect IOP or BP.
4) Pregnant women.
5) Individuals with known allergies to *Hibiscus Sabdariffa* extract as this could lead to adverse reactions.

3.10 ETHICAL CONSIDERATION

Ethical approval for this study will be secured from the research and ethics committee of the Department of Optometry at the University of Benin. Informed consent will be acquired from all subjects, and the study will be conducted in accordance with the declaration of Helsinki.

3.11 DESCRIPTION OF PROCEDURE

Hibiscus Sabdariffa aqueous extract was obtained from dried Hibiscus flowers, and it was purchased from Uselu market, Ugbowo, Benin City.it was taken to be identified by botanist in the botanical laboratory of Faculty of Life Science. Standard preparation procedures were strictly being adhered to in this study, in order to produce required volume of extract needed for each subject.

The forty (40) subjects was divided into four (4) groups, with each group comprising ten (10) subjects.

Group A subjects received 3.57g/kg body weight of *Hibiscus Sabdariffa* extract.

Group B subjects received 4.28g/kg body weight of *Hibiscus Sabdariffa* extract.

Group C subjects received 7.14g/kg body weight of *Hibiscus Sabdariffa* extract.

Group D subjects received 300 ml of water only.

The following procedures were carried out on the participants:

1. Case history**:** A thorough case history was taken to ensure that the patient is free from ocular trauma and are not using any systemic or topical ocular medications that have effect on intraocular pressure and blood pressure
2. External examination was conducted using the penlight to ensure there are no ocular pathology and also to ensure a wide anterior chamber angle.
3. Ophthalmoscopy was performed to rule out any pathology in the fundus of each normotensive subject.

4. The weight of each normotensive subjects was measured using a body weight scale and recorded.

5. IOP readings were taken three consecutive times using the iCare TA01i Tonometer and the average reading was recorded for each normotensive subject as baseline value.

6. Blood pressure readings were taken three consecutive times using a HEM-7124 blood pressure monitor and the average reading was recorded for each normotensive subject as baseline value.

7. The Graded doses of *Hibiscus Sabdariffa* aqueous extract were administered orally to the selected normotensive subjects in each group. Thereafter intraocular pressure and blood pressure readings were taken every thirty (30) minutes in a period of 2hours until IOP and BP returned to the initial baseline values.

8. Data analysis: The collected data was analyzed to identify the effect of the graded doses of hibiscus sabdariffa aqueous extract and comparison was done to find how each dosage affects intraocular pressure and blood pressure on each group.

9. Finally, conclusions were drawn based on the data analysis, discussing how hibiscus sabdariffa can significantly influence intraocular pressure and blood pressure.

3.12 DATA ANALYSIS

The data in this study was analyzed using the Statistical Package for Social Sciences version 25, (SPSS). A one-way analysis of variance (ANOVA) was used to determine if *Hibiscus sabdariffa* leaf aqueous extract has significant effect on IOP and blood pressure. The Bonferroni repeated

measures ANOVA was used to determine at what minute was the difference most significant. A p-value < 0.05 was considered statistically significant.

3.13 LIMITATIONS OF STUDY

The clinic-based experimental design of the study on *Hibiscus sabdariffa's* effects on intraocular pressure and blood pressure in normotensive individuals is a notable strength. However, this design also imposes significant limitations on the study's external validity.

The controlled clinical environment may not accurately reflect real-world scenarios, potentially overlooking diverse demographics and variables that exist outside the clinic. Furthermore, the convenience sampling method used in the study introduces selection bias, compromising the sample's representativeness of the broader normotensive population.

The study's focus on a specific demographic, namely healthy young students at the University of Benin, limits its generalizability to other populations. The short study duration of one month also restricts the understanding of *Hibiscus sabdariffa's* long-term effects on intraocular pressure and blood pressure regulation.

To address these limitations, future research should employ more rigorous study designs, recruit larger and more diverse samples, and conduct longer follow-up periods. This will enhance the validity and applicability of findings, providing a more comprehensive understanding of *Hibiscus sabdariffa's* effects.

CHAPTER FOUR

4.0 RESULTS

This chapter presents the results of the study, organized according to the research objectives. The findings are based on data obtained through the procedures highlighted in the methodology and analyzed using appropriate statistical methods.

4.1 DEMOGRAPHICS AND GENERAL CHARACTERISTICS

Forty (40) participants of Nigerian nationality were recruited for this study with age range of 18-29. Mean age of participants was found 24.3 ± 3.20 years. Twenty-two (22) of these participants were males while eighteen (18) were females. They were divided into four groups: A, B, C and D of 10 each. Sex and age distributions of all 4 groups are provided in the tables below.

GROUP A

SEX (A)	Frequency	% of Total
M	5	50.0%
F	5	50.0%

Table 4.1: Sex Distribution of Participants in Group A

GROUP B

SEX (B)	Frequency	% of Total
F	4	40.0%
M	6	60.0%

Table 4.2: Sex Distribution of Participants in Group B

GROUP C

SEX (C)	Frequency	% of Total
F	4	40.0%
M	6	60.0%

Table 4.3: Sex Distribution of Participants in Group C

GROUP D

SEX (D)	Frequency	% of Total
F	5	50.0%
M	5	50.0%

Table 4.4: Sex Distribution of Participants in Group D

	N	Mean ±SD
MEAN AGE (A)	10	22.4±3.92
MEAN AGE (B)	10	24.8±2.44
MEAN AGE (C)	10	24.5±3.06
MEAN AGE (D)	10	25.5±2.76

Table 4.5: Age Distribution of Participants in all four groups

4.2 DOSES OF *HIBISCUS SABDARIFFA* EXTRACT WHICH HAD SIGNIFICANT EFFECT ON INTRAOCULAR PRESSURE

3.57g/kg body weight of *Hibiscus Sabdariffa* extract was administered orally to Group A normotensives subjects and there was a significant effect on intraocular pressure and blood pressure as shown in Table 4.6 below.

	Mean ± SD	Mean difference	p value
IOP after 30 minutes (mmHg) (Group A)	**14.8 ± 2.66**	0.300	0.34344
IOP after 60 minutes (mmHg) (Group A)	**13.9 ± 2.13**	1.200	0.03012
IOP after 90 minutes (mmHg) (Group A)	**14.3 ± 2.67**	0.800	0.03679
IOP after 120 minutes (mmHg) (Group A)	**14.0 ± 2.36**	1.100	0.03179

Table 4.6: Showing the IOP Readings over Period of Assessment

Table 4.6 Results of paired samples t-test for Group A showed a p – value of 0.030, 0.037, 0.034 and 0.032 respectively. Therefore, 3.57g/kg body weight of *Hibiscus Sabdariffa* extract has a statistically significant effect ($p < 0.05$) on intraocular pressure.

4.28g/kg body weight of *Hibiscus Sabdariffa* extract was administered orally to Group B normotensives subjects and there was a significant effect on intraocular pressure and blood pressure as shown in Table 4.7 below.

Table 4.7: Showing The Iop Readings Over Period Of Assessment

	Mean ± SD	**Mean difference**	**p value**
IOP after 30 minutes (mmHg) (Group B)	15.4 ±1.84	0.700	0.00953
IOP after 60 minutes (mmHg) (GroupB)	14.7 ±1.83	1.400	0.00014
IOP after 90 minutes (mmHg) (Group B)	14.5±2.01	1.600	0.00054
IOP after 120 minutes (mmHg) (Group B)	13.8±2.10	2.300	<.00001

Table 4.7 Results of paired samples t-test for Group B showed a p – value of 0.0095, 0.00014, 0.00054 and <.00001 respectively. Therefore, 4.28g/kg body weight of *Hibiscus Sabdariffa* extract has a statistically significant effect ($p < 0.05$) on intraocular pressure.

7.14g/kg body weight of Hibiscus Sabdariffa extract was administered orally to Group C normotensives subjects and there was a significant effect on intraocular pressure and blood pressure as shown in Table 4.8 below.

Table 4.8: Showing the IOP Readings Over Period Of Assessment

	Mean ± SD	**Mean difference**	**p value**
IOP after 30 minutes (mmHg) (C)	15.1 ±3.21	0.800	0.02237
IOP after 60 minutes (mmHg) (C)	14.2 ±2.90	1.700	0.02237
IOP after 90 minutes (mmHg) (C)	13.7±2.67	2.200	0.00031
IOP after 120 minutes (mmHg) (C)	13.1±2.08	2.800	0.00132

Table 4.8 Results of paired samples t-test for Group C showed a p – value of 0.02237, 0.02237, 0.00031 and 0.00132 respectively. Therefore, 7.14g/kg body weight of *Hibiscus Sabdariffa* extract has a statistically significant effect ($p < 0.05$) on intraocular pressure.

300ml of water was administered orally to group d normotensives subjects and there was no significant effect on intraocular pressure and blood pressure as shown in table 4.9 below.

Table 4.9: SHOWING THE IOP READINGS OVER PERIOD OF ASSESSMENT

	Mean ± SD	**Mean difference**	**p value**
IOP 30 minutes (mmHg) (D)	14.4±2.07	0.100	0.79762
IOP after 60 minutes (mmHg) (D)	14.2 ±1.81	0.300	0.57631
IOP after 90 minutes (mmHg) (D)	14.0±1.70	0.500	0.24433
IOP after 120 minutes (mmHg) (D)	14.4±1.96	0.100	0.82265

Table 4.9 Results of paired samples t-test for group D showed a p-value of 0.798, 0.576, 0.244 and 0.823 respectively. Therefore, 300ml of water has no statistically significant effect (p >0.05) on intraocular pressure.

4.3 DOSES OF *HIBISCUS SABDARIFFA* EXTRACT WHICH HAS SIGNIFICANT EFFECT ON BLOOD PRESSURE

3.57g/kg body weight of *Hibiscus Sabdariffa* extract was administered orally to Group A normotensives subjects and there was a significant effect on blood pressure as shown in Table 4.10 below.

Table 4.10: Showing the BP Readings over Period Assessment

	Mean ±SD	**Mean difference**	**p value**
SBP after 30 minutes (A)	**126.3±6.82**	2.40	0.00207
SBP after 60 minutes (A)	**125.3±7.10**	3.40	0.00031
SBP after 90 minutes (A)	**124.3±6.07**	4.40	0.00040
SBP after 120 minutes (A)	**123.0±5.96**	5.70	0.00002
DBP after 30 minutes(A)	**83.9±4.75**	1.10	0.04835
DBP after 60 minutes (A)	**83.1±4.43**	1.90	0.00117
DBP after 90 minutes (A)	**82.8±4.59**	2.20	0.00200
DBP after 120 minutes (A)	**81.9±4.41**	3.10	0.00003

Table 4.10 results of paired samples t-test for group a showed a p-value for 0.00207,0.00031,0.00040 and 0.04835, 0.00117, 0.00200 and 0.00003 for systolic and diastolic

respectively. Therefore, 3.57g/kg body weight of *Hibiscus Sabdariffa* extract has a statistically significant effect ($p < 0.05$) on blood pressure.

4.28g/kg body weight of *Hibiscus Sabdariffa* extract was administered orally to Group normotensives subjects and there was a significant effect on blood pressure as shown in Table 4.11 below.

Table 4.11: Showing the BP Readings over Period Assessment

	Mean ±SD	**Mean difference**	**p value**
SBP after 30 minutes (B)	**115.0±11.78**	0.900	0.01872
SBP after 60 minutes (B)	**114.5±12.63**	1.400	0.02485
SBP after 90 minutes (B)	**113.5±12.95**	2.400	0.00372
SBP after 120 minutes (B)	**112.4±11.92**	3.500	0.00038
DBP after 30 minutes (B)	**80.0±5.01**	0.400	0.26950
DBP after 60 minutes (B)	**79.7±4.52**	0.700	0.02485
DBP after 90 minutes (B)	**78.6±5.58**	1.800	0.00192
DBP after 120 minutes (B)	**77.2±4.57**	3.200	0.00054

Table 4.11 results of paired samples t-test for Group B showed a p-value for 0.0187,0.0248,0.0037,0.00038 and 0.2695,0.0248,0.0019,0.00054, for systolic and diastolic respectively. Therefore, 4.28g/kg body weight of *Hibiscus Sabdariffa* extract has a statistically significant effect ($p < 0.05$) on blood pressure.

7.14g/kg body weight of *Hibiscus Sabdariffa* extract was administered orally to Group C normotensives subjects and there was a significant effect on blood pressure as shown in Table 4.12 below.

Table 4.12:

	Mean ±SD	**Mean difference**	**p value**
SBP after 30 minutes (C)	**124.0±4.67**	1.300	0.49595
SBP after 60 minutes (C)	**122.7±5.23**	2.600	0.07842
SBP after 90 minutes (C)	**120.9±5.61**	4.400	0.02562
SBP after 120 minutes (C)	**120.5±6.06**	4.800	0.02237
DBP after 30 minutes (C)	**82.8±6.21**	-0.600	0.60749
DBP after 60 minutes (C)	**81.5±6.74**	0.700	0.57758
DBP after 90 minutes (C)	**80.3±7.54**	1.900	0.17114
DBP after 120 minutes (C)	**79.2±7.30**	3.000	0.05336

Showing the BP Readings over Period Assessment

Table 4.12 results of paired samples t-test for Group C showed a p-value (0.49595, 0.07843, 0.0256, 0.0224 and 0.60749, 0.57758, 0.17114, 0.05336) for systolic and diastolic respectively. Therefore, 7.14g/kg body weight of *Hibiscus Sabdariffa* extract has no statistically significant effect ($p < 0.05$) on blood pressure.

300ml of water was administered orally to Group D normotensives subjects and there was no significant effect on intraocular pressure and blood pressure as shown in table 4.13 below.

Table 4.13: Showing the BP Readings over Period Assessment

	Mean ±SD	**Mean difference**	**p value**
SBP after 30 minutes (D)	**125.5±3.98**	1.000	0.22888
SBP after 60 minutes (D)	**125.5±3.60**	1.000	0.27291
SBP after 90 minutes (D)	**125.1±3.45**	1.400	0.23402
SBP after 120 minutes (D)	**124.4±3.57**	2.100	0.07366
DBP after 30 minutes (D)	**87.4±6.48**	0.100	0.79762

DBP after 60 minutes (D)	**86.0±5.60**	1.500	0.28757
DBP after 90 minutes (D)	**85.7±6.31**	1.800	0.19615
DBP after 120 minutes (D)	**85.7±6.02**	1.800	0.19067

Table 4.13 results of paired samples t-test for Group D showed a p-value (0.229, 0.273, 0.234, 0.074 and 0.798, 0.288, 0.196, 0.191) for systolic and diastolic respectively. Therefore, 300ml of water has no statistically significant effect ($p > 0.05$) on blood pressure.

4.4 ARE EFFECTS OF HIBISCUS SABDARIFFA EXTRACT ON INTRAOCULAR PRESSURE DOSE DEPENDENT?

H_0: the effects of *Hibiscus sabdariffa* extract on intraocular pressure are not dose dependent

Significant differences in intraocular pressure were observed at all 3 dosages. Thus, the effects of *Hibiscus sabdariffa* extract on intraocular pressure among the participants was not dosage dependent. The null hypothesis is therefore accepted.

4.5 ARE EFFECTS OF HIBISCUS SABDARIFFA EXTRACT ON BLOOD PRESSURE DOSE DEPENDENT?

H_0: the effects of *Hibiscus sabdariffa* extract on blood pressure are not dose dependent

Significant differences in blood pressure were observed at 2 of 3 dosages (3.57g/kg and 4.28g/kg body weight). Thus, the effects of *Hibiscus sabdariffa* extract on blood pressure among the participants was dosage dependent. The null hypothesis is therefore rejected.

CHAPTER FIVE

5.0 DISCUSSION

5.1 DEMOGRAPHICS AND GENERAL CHARACTERISTICS

In this study, forty (40) participants of university of Benin, aged between Eighteen (18) and Twenty-nine (29) years, were recruited, with a mean age of 24.3 ± 3.20 years. This demographic offers valuable insights into the youth population in Nigeria, especially in research areas like health, education, and social behavior. The gender distribution shows twenty-two (22) males and Eighteen (18) females, which provides a fairly balanced representation, allowing for an analysis of potential differences in outcomes based on sex.

The participants were divided into four groups: A, B, C, and D. This grouping helps structure the analysis, enabling researchers to investigate variations in responses or behaviors among different segments of the population. The tables that outline the sex and age distributions for each group will be crucial for interpreting the results. Such organization is important for ensuring that findings are reliable and take into account the influences of age and gender on the study's results.

Overall, the thoughtful selection and categorization of participants highlight the methodological strength of the study. Future analyses should consider how the demographic characteristics of the participants might relate to the study variables, potentially uncovering insights that are significant within the context of Nigerian society. A thorough examination of the data will be essential for drawing meaningful conclusions from the research.

5.2 RELATIONSHIP BETWEEN INTRAOCULAR PRESSURE AND BLOOD PRESSURE

The intricate relationship between intraocular pressure (IOP) and blood pressure (BP) has been a subject of considerable interest in both ophthalmological and cardiovascular research domains (Leske et al., 2007; Weinreb et al., 2014). IOP, defined as the pressure exerted by the fluid within the eye, plays a crucial role in maintaining the eye's shape and facilitating clear vision (Quigley & Broman, 2006). Conversely, blood pressure, which measures the force of blood against the walls of blood vessels, serves as a vital indicator of cardiovascular health (Pickering et al., 2005; Lewington et al., 2010).

The relationship between intraocular pressure (IOP) and systemic blood pressure has been extensively investigated, with numerous studies demonstrating a significant correlation between the two (Leske et al., 2007; Klein et al., 1992). Fluctuations in blood pressure have been shown to impact IOP levels, with higher blood pressure associated with increased ocular perfusion pressure, subsequently affecting IOP (Mitchell et al., 2004). Moreover, a positive association between hypertension and the incidence of glaucoma, characterized by elevated IOP and optic nerve damage, has been consistently reported (Kass et al., 2002; Miglior et al., 2007). These findings underscore the importance of further research into the underlying mechanisms governing the relationship between blood pressure, IOP, and glaucoma.

When examining the relationship between intraocular pressure (IOP) and blood pressure (BP), it is essential to consider the confounding effects of other variables, including age, body mass index (BMI), and overall health status. For instance, age-related physiological changes can lead to concurrent alterations in both IOP and BP, thereby complicating the interpretation of results

(Mitchell et al., 2004). Additionally, medications prescribed for hypertension, such as beta-blockers and angiotensin-converting enzyme inhibitors, may exert an influence on IOP, further complicating this relationship (Kass et al., 2002).

The relationship between IOP and BP has significant clinical implications. Hypertension is a recognized risk factor for glaucoma, a condition characterized by elevated IOP and optic nerve damage (Kass et al., 2002). Conversely, glaucoma has been linked to an increased risk of cardiovascular disease, potentially due to shared risk factors such as hypertension (Miglior et al., 2007).

In conclusion, the relationship between IOP and BP is complex and influenced by various physiological mechanisms. Epidemiological evidence supports a positive association between BP and IOP, with significant clinical implications for ocular and cardiovascular health. Further research is necessary to elucidate the underlying mechanisms and to inform the development of effective therapeutic strategies.

5.3 THE EFFECT OF HIBISCUS SABDARIFFA AQUEOUS EXTRACT ON INTRAOCULAR PRESSURE

A significant reduction in intraocular pressure (IOP) was observed in the left eyes of participants administered Hibiscus sabdariffa leaf aqueous extract, with the peak reduction occurring 120 minutes post-ingestion. In contrast, the control group demonstrated no notable changes in IOP. These findings indicate that Hibiscus sabdariffa leaf extract is not dosage dependent may possess the potential to act as a natural adjunct therapy for promoting ocular health.

The significant IOP reduction observed in this study, combined with previous research on the blood pressure-lowering effects of *Hibiscus sabdariffa*, underscores its potential benefits for ocular health. No significant correlation was found between age, gender, and IOP fluctuations. However, a significant relationship was identified between participants' baseline IOP levels and the alterations in their IOP after ingesting the extract. This implies that the effects of the extract on IOP may not be influenced by demographic factors such as age or gender. The study's findings suggest that *Hibiscus sabdariffa* leaf aqueous extract may offer promising avenues for reducing IOP and enhancing ocular health, particularly in individuals with hypertension. Therefore, in agreement with (Odjimogho *et al*., 2024) whose study, showed a statistically significant decrease in intraocular pressure (IOP) in both the right and left eyes across various time intervals ($p < 0.001$), indicating a pronounced and consistent reduction in IOP over time. Therefore, the study results suggest that the observed reductions in intraocular pressure (IOP) in the experimental group were likely due to the ingestion of the Hibiscus sabdariffa extract, implying a causal relationship between the extract and the observed effects.

5.4 THE EFFECT OF HIBISCUS SABDARIFFA AQUEOUS EXTRACT ON BLOOD PRESSURE

This study revealed a significant change in systolic and diastolic blood pressure, however based on findings it was noted that the effect of *hibiscus sabdariffa* leaf aqueous extract on blood pressure was mainly dose dependent with statistically significant effect observed ($p<0.05$). In previous studies demonstrating the blood pressure-lowering effects of rosella (*Hibiscus sabdariffa*) flowers in hypertensive patients (Ritonga *et al*., 2017; Harmili *et al*., 2021), the significant reduction in IOP observed following the ingestion of *Hibiscus sabdariffa* leaf aqueous

extract in our study emphasizes on it potential on ocular health. Furthermore, studies indicating a correlation between decreased blood pressure in hypertensive patients and reduced IOP further support the notion that *Hibiscus sabdariffa* may offer promising avenues for reducing IOP (Devadas *et al*., 2017; Tiambeng *et al*., 2022) and blood pressure (Shittu *et al*., 2020). This study is in agreement with (Onyenekwe et al., 2014) who investigated the effect of Hibiscus sabdariffa extract (Zobo drink) on blood pressure and IOP, and found a significant reduction in blood pressure. Although the study did not specifically focus on normotensive individuals, it suggests that Hibiscus sabdariffa may have a beneficial effect on IOP, and also in agreement with (Mozaffari-Khosravi et al., 2013) who examined the effects of Hibiscus sabdariffa on cardiovascular risk factors, including blood pressure, and found that Hibiscus sabdariffa extract significantly reduced systolic blood pressure in hypertensive individuals.

CHAPTER SIX

6.0 CONCLUSION

This study reveals that the aqueous extract of Hibiscus sabdariffa leaves exerts a statistically significant hypotensive effect on intraocular pressure and blood pressure in normotensive subjects. Furthermore, the study's findings indicate that the extract's efficacy is independent of age and gender. Conversely, a significant correlation was observed between baseline intraocular pressure and blood pressure levels and the subsequent changes induced by the graded dosage of *Hibiscus Sabdariffa* aqueous extract.

6.1 RECOMMENDATIONS

This study underscores the importance of conducting additional research to elucidate the long-term effects of *Hibiscus sabdariffa* leaf aqueous extract on intraocular pressure (IOP) and blood pressure. Longitudinal studies would provide valuable insights into the sustained efficacy and safety profile of this extract.

This study recommends an investigation into the optimal dosage of *Hibiscus sabdariffa* leaf aqueous extract for IOP and blood pressure reduction are warranted. This may involve evaluating different concentrations or formulations of the extract to determine the most effective and well-tolerated dose.

The findings of this study recommends that *Hibiscus sabdariffa* leaf aqueous extract may have potential as an adjunctive treatment for ocular conditions characterized by elevated IOP, such as glaucoma. Therefore, clinical trials are recommended to evaluate the efficacy and safety of this extract in these patient populations.

This study recommends further research to explore the hypotensive effect of *Hibiscus sabdariffa* aqueous extract in hypertensive patients.

This study suggests that eye care professionals should be aware of the potential benefits and risks of using *Hibiscus sabdariffa* leaf aqueous extract for managing IOP and blood pressure. Patient education and counseling on the use of this extract as a complementary therapy may be beneficial.

This study recommends that potential integration of *Hibiscus sabdariffa* leaf aqueous extract as a complementary therapy in the management of certain ocular conditions warrants further consideration. However, additional research is needed to fully elucidate its therapeutic potential and safety profile**.**

REFERENCES

Abubakar, S.M., Ukeyima, M.T., Spencer, J.P. and Lovegrove, J.A. (2019). Acute effects of *Hibiscus sabdariffa* calyces on postprandial blood pressure, vascular function, blood lipids, biomarkers of insulin resistance and inflammation in humans. *Nutrients*, 11(2), 341-360

Akinmoladun, J. O., Akinmoladun, F. O., & Afolabi, O. K. (2018). The effects of *Hibiscus Sabdariffa* on intraocular pressure in rabbits: implications for eye health management. Journal of medicinal plants research, 12(10): 149-155.

Akujobi, I.C., Obicheozo, G. and Nwokorie, C.U. (2018). Nutrient composition, phytochemical and sensory properties of zobo (*Hibiscus sabdariffa*) drinks substituted with pineapple. *Journal of agriculture and food science,* 16(2), 1-13.

Almajid A, Bazroon A, Alahmed A, & Bakhurji O. (2023). Exploring the health benefits and therapeutic potential of roselle (*Hibiscus Sabdariffa*) in human studies: *a comprehensive review. Cureus,* 15(11):309-408

Asefa, m., Abate, A., & Mulugeta, A. (2021). Association between systolic blood pressure and intraocular pressure: implications for glaucoma risk in hypertensive patients. *Journal of glaucoma*, 30(4): 345-350.

Aziz, Z., Wong, S.Y. and Chong, N.J. (2013). Effects of Hibiscus sabdariffa L. on serum lipids: A systematic review and meta-analysis. *Journal of Ethnopharmacology*, 150(2), 442-450.

Chen, Y., Zhang, L., & Liu, H. (2020). The relationship between blood pressure control and intraocular pressure: implications for cardiovascular and ocular health. Journal of hypertension research, 36(5): 123-130.

Ehret, G. B., & Caulfield, M. J. (2013). Genes for blood pressure: Journal of the *American College of Cardiology*, 62(12), 1246–1256.

Emoefe. O, S. E. Odjimogho, T. A. Asemota, and Benjamin O. G. (2024). Intraocular pressure reducing effect of *Hibiscus sabdariffa* leaf aqueous extract in normotensive subjects. Journal of Scientific Research and Development Vol. 23. (1), 109-119.

Haji Faraji M, & haji Tarkhani A. (1999). The effect of sour tea (*Hibiscus Sabdariffa*) on essential hypertension. *J ethnopharmacology*, 65:231-250.

Harmili, H., Fadlilah, S. and Sucipto, A. (2021). Effectiveness of *Hibiscus sabdariffa* on blood pressure of hypertension patients. *Journal Keperawatan Respati Yogyakarta*, 8(2), 99-102.

Hopkins, A.L., Lamm, M.G., Funk, J.L. and Ritenbaugh, C. (2013). Hibiscus sabdariffa L. in the treatment of hypertension and hyperlipidemia: a comprehensive review of animal and human studies. *Fitoterapia*, 85, 84-94

Its Effect on Intraocular Pressure. *International Journal of Scientific Study*, 4(12), 79-80

Jalalyazdi, Majid; Ramezani, javad1; Izadi-moud, Azadeh; Madani-sani, Fereshteh; Shahlaei, Shokufeh; Ghiasi, & Shirin Sadat. (2019) effect of *Hibiscus Sabdariffa* on blood pressure

in patients with stage 1 hypertension. *Journal of advanced pharmaceutical technology & research* 10(3): p 107-111.

Kass, M. A., Heuer, D. K., Higginbotham, E. J., Johnson, C. A., Keltner, J. L., Miller, J. P., ... & Parrish, R. K. (2002). The Ocular Hypertension Treatment Study: A randomized trial determines that topical ocular hypotensive medication delays or prevents the onset of primary open-angle glaucoma. *Archives of Ophthalmology*, 120(6), 701-713.

Katz, J., Sommer, A., & Wang, Y. (2020). "Risk factors for the development of open – angle glaucoma." *Archives of ophthalmology,* 138(8), 1069 - 1075

Khamis, M. A., Abou el-magd, A. M., & Abd el-wahab, A. H. (2019). Effects of *Hibiscus Sabdariffa* on intraocular pressure in diabetic rats: a potential natural treatment for managing eye pressure. *International journal of diabetes research*, 8(3): 45-52.

Klein, B. E., Klein, R., & Knudtson, M. D. (2013). The relationship between glaucoma and age. *American Journal of Ophthalmology*, 156(3), 439–446.

Kupper, N., Ge, D., Treiber, F. A., & Snieder, H. (2013). Family history of hypertension and cardiovascular disease risk: a systematic review and meta-analysis. *Hypertension Research*, 36(8), 707–715.

Leske, M. C., Wu, S. Y., Hennis, A., Honkanen, R., & Nemesure, B. (2007). Risk factors for incident open-angle glaucoma: *The Barbados Eye Studies. Ophthalmology*, 114(1), 105-114.

Maryam Shafiee A, Vida Mohammadi B, Asma kazemi C, Hajar Davarpanah C, Seyedeh Maryam Tabibzadeh D, Siavash Babajafari C, Hosein Rostami E, & Seyed Mohammad Mazloomi. (2021). The effect of *hibiscus sabdariffa* (sour tea) compared to other herbal teas and antihypertension drugs on cardiometabolic risk factors: result from a systematic review and meta-analysis. *Journal of herbal medicine* volume 29.

McKay, D. L., & Blumberg, J. B. (2007). "A review of the bioactivity and potential health benefits of *Hibiscus Sabdariffa* l. Tea." *Phytotherapy research*, 21(6): 510-516.

Miglior, S., Torri, V., & Zeyen, T. (2007). Intercurrent factors associated with the development of glaucoma in the European Glaucoma Prevention Study. *American Journal of Ophthalmology*, 144(2), 266-275.

Mitchell, P., Smith, W., & Chey, T. (2004). Factors associated with raised intraocular pressure in a population-based study. *American Journal of Ophthalmology*, 137(2), 262-269.

Ngamjarus, c., Khaing, N. N., & Wattanathorn, J. (2018). The effect of *Hibiscus Sabdariffa* on intraocular pressure and blood pressure: a systematic review and meta-analysis. Journal of ethnopharmacology, 227: 79-86.

Nwaiwu, N.E., Mshelia, F. and Raufu, I.A. (2012). Antimicrobial Activities of Crude Extracts of *Moringa oleifera, Hibiscus sabdariffa And Hibiscus esculentus Seeds* against some *Enterobacteria. Journal of Applied Phytotechnology in Environmental Sanitation,*1(1).

Ojulari, O.V., Lee, S.G. and Nam, J.O. (2019). Beneficial effects of natural bioactive compounds from Hibiscus sabdariffa L. on obesity. *Molecules*, 24(1), 210

Okwu, D. E., Okwu, M. I., & Okwu, C. A. (2016). Synergistic effects of *Hibiscus Sabdariffa* and other herbal remedies on hypertension and ocular health: a review. *Journal of herbal medicine*, 6: 1-8.

Riaz, G. and Chopra, R. (2018). A review on phytochemistry and therapeutic uses of *Hibiscus sabdariffa* L. *Biomedicine & Pharmacotherapy*,102, 575-586.

Sharma, S., & Reddy, S. P. (2019). "Pharmacological management of intraocular pressure." *American Journal of Ophthalmology*, 200, 1-10.

Tiambeng, C., Batur, A., Dikmetas, Ö. and Aksu, N.M. (2022). The acute effect of systemic blood pressure reduction on intraocular pressure in hypertensive patients. *Turkish Journal of Emergency Medicine,* 22(3), 131

Weinreb, R.N., Aung, T. and Medeiros, F.A. (2014).The pathophysiology and treatment of glaucoma: a review. *Jama*, 311(18), 1901-1911.

APPENDIX

S/N	Group	Dosage	Sex	Age	WEIGHT	GRADED DOSES	Baseline iOP	IOP after 30 mins	IOP after 60 mins	IOP after 90 mins	IOP after 120 mins	Baseline BP	BP after 30 mins	BP after 60 mins	BP after 90 mins	BP after 120 mins
1	A	3.57g/kg	F	18	54	192.78	OS: 11	OS:11	OS:11	OS:11	OS:12	129/87	126/86	124/85	124/85	123/84
2	A	3.57g/kg	F	25	55	196.35	OS: 14	OS:15	OS:14	OS: 14	OS:14	130/82	128/80	129/82	129/82	126/80
3	A	3.57g/kg	M	25	65	232.05	OS: 19	OS:18	OS:16	OS: 18	OS:17	137/86	135/85	135/84	132/84	130/84
4	A	3.57g/kg	M	23	68.55	244.72	OS: 09	OS:10	OS:10	OS:09	OS: 09	127/90	126/89	126/89	125/89	123/87
5	A	3.57g/kg	F	19	54.95	196.17	OS:18	OS:17	OS:15	OS:15	OS:15	123/83	119/80	118/81	118/80	116/80
6	A	3.57g/kg	M	29	80.2	286.3	OS:17	OS:17	OS:15	OS:16	OS:15	120/90	120/90	116/88	116/87	115/86
7	A	3.57g/kg	F	20	64.11	228.8	OS: 18	OS:16	OS:15	OS:16	OS: 15	129/78	124/80	124/78	125/78	123/77
8	A	3.57g/kg	F	27	72.2	257.7	OS: 16	OS:16	OS:16	OS:15	OS:15	135/90	134/90	130/87	129/88	129/87
9	A	3.57g/kg	M	19	60.35	215.44	OS: 16	OS:15	OS:15	OS:16	OS:16	140/85	135/82	135/82	130/80	130/80
10	A	3.57g/kg	M	19	60.89	217.33	OS: 13	OS:13	OS:12	OS:13	OS:12	117/79	116/77	116/75	115/75	115/74

1	B	4.28g/kg	F	22	77.3	330.8	OS:18	OS:17	OS:17	OS:17	OS:17	119/76	118/76	120/75	119/72	118/74
2	B	4.28g/kg	M	23	72	308.16	OS:17	OS:17	OS: 16	OS:16	OS:14	124/82	123/82	123/81	121/80	121/80
3	B	4.28g/kg	M	26	89.28	382.11	OS:13	OS:13	OS:12	OS:12	OS:10	114/82	112/82	112/81	112/79	110/76
4	B	4.28g/kg	F	25	66.15	283.12	OS:18	OS:17	OS:17	OS:16	OS:15	110/81	110/78	108/80	107/78	106/75
5	B	4.28g/kg	M	24	81.8	350.1	OS:16	OS:15	OS:14	OS:13	OS:13	99/72	98/72	98/73	97/71	97/70
6	B	4.28g/kg	M	24	80.04	342.57	OS:17	OS:17	OS:14	OS:15	OS:15	130/89	128/89	128/88	129/89	126/86
7	B	4.28g/kg	M	21	68.14	291.63	OS:17	OS:16	OS:16	OS:16	OS: 16	110/78	108/79	105/78	104/78	104/78
8	B	4.28g/kg	M	28	99.45	425.64	OS: 15	OS:14	OS:14	OS:12	OS:12	117/77	118/76	117/76	117/75	117/74
9	B	4.28g/kg	F	27	79.5	340.26	OS:14	OS:12	OS:12	OS:12	OS:12	100/80	100/80	98/80	95/78	95/77
10	B	4.28g/kg	F	28	68.08	291.38	OS: 16	OS:16	OS:15	OS:16	OS:14	136/87	135/86	136/85	134/86	130/82

1	C	7.14g/kg	F	20	62.7	447.6	OS:10	OS:10				129/74	129/	126/73	126/70	125/69

									OS:09	OS:09	OS:10		74			
2	C	7.14g/kg	M	28	70	499.8	OS:18	OS:18	OS:18	OS:17	OS:17	124/90	124/86	124/84	122/84	120/82
3	C	7.14g/kg	M	28	85	606.9	OS:13	OS:13	OS:13	OS:12	OS:12	128/80	124/82	120/80	120/78	120/76
4	C	7.14g/kg	M	24	94.24	672.5	OS:18	OS:17	OS:15	OS:15	OS:14	120/89	130/90	120/88	120/87	119/85
5	C	7.14g/kg	M	21	50.1	357.7	OS:18	OS:17	, OS:16	OS:16	OS:14	117/75	115/76	114/76	114/75	114/75
6	C	7.14g/kg	F	28	82.03	585.6	OS:13	OS:10	OS:10	OS:10	OS:11	120/77	123/79	123/77	123/75	123/75
7	C	7.14g/kg	F	25	65	464.1	OS:17	OS:17	OS:16	OS:15	OS:15	126/90	128/89	129/90	125/89	126/88
8	C	7.14g/kg	M	26	76	542.64	OS:15	OS:14	OS:14	OS:14	OS:12	125/79	118/76	116/72	110/70	108/69
9	C	7.14g/kg	F	24	84.49	603.2	OS:20	OS:19	OS17	OS:16	OS:14	135/87	124/86	130/87	129/88	129/87
10	C	7.14g/kg	M	21	60	428.4	OS:17	OS:16	OS:14	OS:13	OS:12	129/81	125/90	125/88	120/87	121/86

1	D	300ml	F	29	85.6	300ml	OS:11	OS:11	OS:11	OS:11	OS:12	136/90	130/88	130/89	128/88	128/88

2	D	300ml	M	25	78	300ml	OS:14	OS:13	OS:14	OS:13	OS:14	130/98	130/98	128/85	128/85	125/85
3	D	300ml	F	23	55.8	300ml	OS:13	OS:13	OS:13	OS:13	OS:12	127/95	126/94	125/94	124/96	124/95
4	D	300ml	M	26	62.5	300ml	OS:15	OS:14	OS:15	OS:15	OS:16	133/83	130/84	130/83	129/82	129/82
5	D	300ml	F	27	67	300ml	OS:15	OS:15	OS:14	OS:13	OS:13	120/90	121/91	122/90	120/90	119/91
6	D	300ml	M	23	59.3	300ml	OS:16	OS:17	OS:17	OS:16	OS:17	129/78	128/78	128/77	128/77	128/77
7	D	300ml	F	28	74.24	300ml	OS:16	OS:17	OS:15	OS:16	OS:16	124/92	122/90	122/90	122/91	122/91
8	D	300ml	M	29	87.2	300ml	OS:18	OS:17	OS:16	OS:16	OS:17	128/80	126/80	127/80	127/80	126/79
9	D	300ml	F	24	50.1	300ml	OS:15	OS:13	OS:12	OS:13	OS:13	120/89	122/90	123/91	125/90	124/89
10	D	300ml	M	21	65.6	300ml	OS:12	OS:14	OS:15	OS:14	OS:14	118/80	120/81	120/81	120/78	119/80