



## Hibiscus Sabdariffa Tea in Naturopathic Cardiology Treatment

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### Abstract

### Original Research Article

This Doctor of Naturopathic Medicine degree thesis examines the development of a natural hypertensive Tea for use in Naturopathic Cardiology. Natural Medicinal products play significant role in the management of Natural Cardiology; hence there is the need for research into natural products. This Doctor of Naturopathic Medicine student formulated and developed the product at his Research center at Tema Community 18, Ghana-West Africa. The product was further sent to the Kwame Nkrumah University of Science and Technology (KNUST) at Kumasi-Ashanti region in Ghana for animal analysis as part of the Food and Drugs Authority requirement for herbal product registration. The product has the brand name 'Dr. Nyarkotey Tea' with the hibiscus sabdariffa as the active ingredient with batch number 01D19 for the management of Hypertension, diabetic conditions and support for general wellbeing. His research center; RNG introduced bioenergization into the plant to increase its shelf life, reduce microbial loads and improve its efficacy. The Faculty of Pharmacy and Pharmaceutical Sciences of the University employed three diverse trials for the product (in a tea form of thirty (30) bags) conducted through Department of Pharmaceutics to assess the microbial loads, the Department of Pharmacology to assess the efficacy, acute and Sub chronic Toxicity test and the Department of Pharmacognosy, to assess the phytochemical and Physicochemical properties of the formulation. The formulator's dosage is two bags twice (x2) daily for diabetics and hypertensive patients. An observational study was further conducted on patients at the RNG Medicine Research Lab to assess the impact of the Tea on Hypertensive patients. The product, Dr. Nyarkotey Herbal Tea produced dose-dependent reduction in the arterial blood pressure of the anaesthetized cat comparable to acetylcholine. The depressor effects of acetylcholine and Dr. Nyarkotey Herbal tea on the blood pressure of the anaesthetized cat were inhibited by 72.3+5.21% and 55.6 + 6.82% respectively, suggestive of muscarinic mediation. The remarks states that, as per the findings, Dr. Nyarkotey Herbal Tea has hypotension effect and hence could be use in the management of hypertension. The No-Observable-Adverse-Effect level (OAEL) is greater than five times the stated daily dosage (7.0ml/kg) indicated by the manufacturer. The recommended daily dose is thus within the acceptable margin of safety.

**Key words:** Naturopathic Cardiology, Nyarkotey Hibiscus Tea, Integrative Medicine, Wellness, Cardio protective.

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## DEDICATION

This dissertation is dedicated to all students of Nyarkotey College of Holistic Medicine, Ghana, West Africa and the Natural Medicine community interested in Naturopathic Cardiology.

## ACKNOWLEDGMENTS

First and foremost, I must express my gratefulness to the Almighty God for granting me His grace, favor, energy, wisdom, and guidance to survive this dissertation journey. "After you have suffered for a little while, the God of all grace [who imparts His blessing and favor], who called you to His own eternal

glory in Christ, will Himself complete, confirm, strengthen, and establish you [making you what you ought to be]" (1 Peter 5:10).

I wish to express my profound gratitude to my supervisors and my staff at Nyarkotey College of Holistic Medicine and all those who supported my work. May God bless you all!

## CHAPTER 1

### 1.1 Statement of the Problem

Naturopathic Medicine is one of the benchmarks in addressing Cardiology. Hence, the role

of Naturopathic Cardiology in managing cardiovascular diseases cannot be overruled. More and more people are shifting to Naturopathic remedies in management of hypertension, diabetics and chronic diseases. According to the 2014 Ghana Demographic and Health Survey (GDHS), the overall prevalence of hypertension among persons aged 15–49 years was 13.0%, with nearly half of them being aware of their hypertensive status [1]. A 2010 systematic review and meta-analysis by Bosu [41] also reported a prevalence of adult hypertension between 19% and 48%. A 2019 study by Dosoo *et al.* [2] showed that close to one-quarter of adults who were involved in the survey in the middle belt of Ghana were hypertensive with less than half being aware of their hypertensive status; nearly half of those on treatment had controlled hypertension. Healthcare systems need adequate resources that enable them to screen, educate, and refer identified hypertensive patients for appropriate management to prevent or minimize the development of hypertension-related complications.

There is the need for extensive local research into these remedies. One plant widely revered as beverage in Ghana is the hibiscus sabdariffa flower. However, no local research has been conducted into the tea form of the plant. This is the basis of this Doctor of Naturopathic Medicine degree research which formulated a novel tea from the plant.

## 1.2 Contributions

This thesis revealed the concept of Naturopathic Cardiology introduced into the study of Naturopathic Medicine as a specialty program. Naturopathic cardiology addresses the root cause of cardiovascular diseases and general wellness. The product developed could also be use in an integrative or multidisciplinary approach to the management of cardiovascular diseases especially in hypertension and diabetics.

Conventional cardiologists try to reverse and prevent coronary artery disease and heart failure. I formulated this product so that Naturopath interested in Naturopathic Cardiology can slowly start transitioning patients out of clinical cardiologists' bench and into holistic or naturopathic primary care (whose job would normally include asking if the patient is happy), the world could truly start to prevent and reverse hypertension.

The challenge in Naturopathic cardiology is training of professionals in Ghana and Africa to manage such cases. A handful of naturopathic physicians globally relish and excel in the treatment of cardiovascular conditions. Unfortunately, most naturopathic physicians do not share that confidence and excitement; rather, they feel out of their depth when dealing with the heart. With such wide opportunities to influence the health of the nation, cardiovascular medicine is an area where naturopathic physicians need

to excel. There is an opportunity here to heal a nation, to promote our profession, and to help our conventional colleagues become aware of and enthusiastic about the ability of naturopathic medicine to fill an important niche within the greater medical field. The steps forward in capitalizing on those opportunities are to increase the postgraduate education and training of naturopathic physicians in cardiovascular medicine and other special disciplines and to establish professional organizations to create and uphold standards of practice and training in areas of naturopathic practice focus. A professional board of naturopathic cardiovascular medicine will achieve both of these necessary advances in our profession; it is an idea whose time has come.

This work shows that hibiscus Sabdariffa Tea manufactured in Ghana has hypotensive effect and could be use in the management of hypertension. This is the first of such study in the laboratory in Ghana to be conducted to reveal such an impressive revelation. The study also revealed Nyarkotey Tea made with hibiscus Sabdariffa could be employed in the Naturopathic Cardiology or integrative management of hypertensive cases.

Normalized heart function and whole-body homeostasis improve quality of life and reduce patients reliance on pharmaceuticals. Regardless of the stage of heart disease, with the safe and effective naturopathic cardiology methods using the Nyarkotey Tea, long term and repeated drug therapy can often be minimized or avoided.

## CHAPTER 2

### 2.1 INTRODUCTION

The most important thing about the hibiscus sabdariffa in tea form is that it is one of the richest sources of antioxidants to be use in a beverage. This was revealed in a study published in Nutrition Journal where the investigators elucidated how they developed a comprehensive food database that listed the antioxidant content of more than 3,100 foods, spices, beverages, herbs, and supplements. After analyzing 283 different beverages, hibiscus tea beat matcha green tea when it came to antioxidant content. While green tea is still a very good beverage choice for antioxidants, hibiscus tea tops the list [3].

Both green tea and hibiscus tea are among the top drinks for prostate health. Both types of tea contain potent antioxidants. Studies show that green tea can help prevent prostate cancer from forming and may also slow the growth of aggressive prostate cancer. Studies show that green tea can also benefit men with BPH and prostatitis. Chun-Tang Chiu *et al.* [4] research demonstrated the effect of hibiscus tea to reduced invasiveness of the cancer cells.

Hibiscus tea has also been shown to work as a natural diuretic in a research by Allison L. Hopkins *et al.* [5], increasing both urination and bowel movements. Hibiscus also crushed kidney stones by increasing the flow of water through the kidneys, the concentration of oxalate and other stone forming substances is decreased, and instead of adding to the crystals in the kidneys, watery urine helps dissolve them. This process is not quick enough for most people, but hydration is very important for kidney stones.

As the water leaves the body, it pulls the sodium with it, which is one mechanism by which blood pressure is reduced. As mentioned above, hibiscus tea contains a rich amount of anthocyanin, which is a phenolic compound. It is believed that this active compound is responsible for the tea's cardio-protective effects.

While the blood pressure-lowering effects of hibiscus have been demonstrated in humans in 2004 (Herrera-Arellano *et al.*), 2010 [4] (McKay DL *et al.*), and 2015[5] (Nwachukwu D *et al.*), a 2017 study (Nwachukwu DC *et al.*)[6] has shown that hibiscus not only helps maintain a healthier blood pressure, but it does not harm kidney function. This was also demonstrated in the lab study at Kwame Nkrumah University of Science Technology where Nyarkotey tea sent for analysis proved no harm on the kidneys in 2016. Kidney function can be harmed by high blood pressure [9], so it's important that treatments for high blood pressure do not cause further harm to kidney function.

When suggesting mechanisms for how hibiscus produces these benefits to blood pressure, the researchers cited research works showing that hibiscus increases the ability of blood vessels to relax (called "vasodilation") Obiefuna P *et al.* [10] and also affects a frequent target of blood pressure medications, an enzyme in the kidney called angiotensin-converting enzyme [6] and Nwachukwu DC *et al.* [8].

Although a weakness in this study was the homogenous population studied, the researchers concluded that "Consumption of hibiscus with a standardized amount of 10.04 mg anthocyanins improved renal function in patients with mild to moderate hypertension, with better effects than lisinopril". They added that "Further research is required to explore the possibility of utilizing our important finding and integrating it into our National Health Care Program since hibiscus is easily available and affordable in Nigeria."

A 2012 Tufts University study published in the Journal of Nutrition reported that hibiscus tea demonstrated promising results when pitted against placebo tea. In the double-blind, placebo-controlled study, 65 adults with prehypertension or mild

hypertension were given either three 240-mL servings of either hibiscus or placebo tea daily for six weeks.

At the end of six weeks, adults who had consumed the hibiscus tea had a lower systolic blood pressure when compared with adults in the placebo group, but the same was not true for diastolic pressure. The authors concluded that "daily consumption of hibiscus tea...lowers BP in pre- and mildly hypertensive adults and may prove an effective component of the dietary changes recommended for people with these conditions."

The healthful benefits of hibiscus don't end there. Another study explored the impact of hibiscus extract powder in patients with metabolic syndrome. Metabolic syndrome is a combination of disorders that increase a person's risk of developing diabetes and cardiovascular disease. Components of metabolic syndrome include insulin resistance, obesity, high blood pressure, elevated triglycerides, and low "good" cholesterol (high-density lipoprotein, HDL).

The study evaluated the effects of Hibiscus sabdariffa extract powder on people with and without metabolic syndrome. All the participants took 100-mg capsules of hibiscus extract daily for one month. At the end of the month, individuals with metabolic syndrome showed significantly lower levels of glucose and total cholesterol as well as an increase in HDL levels. Hibiscus extract also lowered triglyceride levels in people with and without metabolic syndrome.

## 2.2 Analysis of Hibiscus Tea on ED

Remember that erections are all about your arteries - nitric oxide in your arteries and nice low blood pressure levels (which indicates higher blood flow):

1. Increased eNOS Activity and Nitric Oxide. We get most of our arterial nitric oxide from the endothelium and this is governed by the eNOS enzyme. It turns out that the polyphenols in hibiscus tea activate this enzyme and cause your endothelium to produce more nitric oxide.

Well, one would say "this is animal study in the lab and not in actual human subjects." You are correct though. Nevertheless, one of the big tests for any possible NO-increasing compounds is whether or not it can produce big drops in blood pressure. In this Doctor of Naturopathic Medicine research, I have reviewed research papers on this; this has been demonstrated in at least five studies, three of which I have acknowledged below.

Also, I do not need to point out that boosting arterial nitric oxide, which is the center of attention in this research, will largely help significantly with mild to moderate erectile dysfunction.

## 2. Endothelial Function. This formula explains this

Erectile function = Endothelial function

The endothelium is the thin layer of cells on the inside of your arteries that are responsible for controlling their expansion and contraction and the nitric oxide that governs the process. Researchers refer to this ability to relax the arteries as "endothelial function," and, generally speaking, endothelial function governs how well and how fast your erections are. (There are exceptions, of course, as low dopamine, venous leakage and other systems can negatively impact erections as well.) In any event, you can probably guess where I am headed: hibiscus tea has been shown to significantly help with endothelial function:

"Diuresis and inhibition of the angiotensin I-converting enzyme were found to be less important mechanisms than those related to the antioxidant, anti-inflammatory, and endothelium-dependent effects to explain the beneficial actions. Notably, polyphenols induced a favorable endothelial response that should be considered in the management of metabolic cardiovascular risks."

Notice that these researchers boldly told physicians to consider using hibiscus in their practices. But how many physicians actually consider natural solutions to chronic disease, even though 99% of the time, chronic disease results from unnatural lifestyles?

Again, an improvement in endothelial function will help the solid majority of men with mild to moderate erectile dysfunction. This is especially true if coupled with a high nitric oxide-based lifestyle.

3. Hypertensive Type II (Adult Onset) Diabetics. This study did a black tea versus hibiscus tea study. (Black tea is known for also improving endothelial function, although this study found the opposite.) The results were very impressive for hibiscus tea:

The mean of systolic BP (SBP) in the ST [hibiscus tea] group decreased from 134.4 11.8 mm Hg at the beginning of the study to 112.7 5.7 mm Hg after 1 month, whereas this measure changed from 118.6 14.9 to 127.3 8.7 mm Hg in the BT group during the same period."

A 16+ point drop in systolic blood pressure should get everyone's attention. Of course, this means that the participants' arteries relaxed or dilated and blood flow increased.

Admittedly, the number of patients was small (60) and another study found that black tea decreased blood flow in a dose dependent manner instead of restricting it.

4. Moderate Essential Hypertension. Patients with essential are often the toughest to treat, because they have no known cause. In a small study, hibiscus provided solid results in just this situation: "Statistical findings showed an 11.2% lowering of the systolic blood pressure and a 10.7% decrease of diastolic pressure in the experimental group 12 days after beginning the treatment, as compared with the first day. The difference between the systolic blood pressures of the two groups was significant, as was the difference of the diastolic pressures of the two groups. Three days after stopping the treatment, systolic blood pressure was elevated by 7.9%, and diastolic pressure was elevated by 5.6% in the experimental and control groups."

5. Prehypertension and Mild Hypertension. Again, this was a fairly small study (65 participants) but provided solid results:

"A standardized method was used to measure BP at baseline and weekly intervals. At 6 wk, hibiscus tea lowered systolic BP (SBP) compared with placebo (-7.2 11.4 vs. -1.3 10.0 mm Hg). Diastolic BP was also lower, although this change did not differ from placebo (-3.1 7.0 vs. -0.5 7.5 mm Hg)." This group is particularly relevant in my opinion, because we clearly have quite a few prediabetic men on the Peak Testosterone Forum.

6. Protection Against Arterial Plaque. One thing that can lower your nitric oxide and endothelial function over time is a buildup in plaque in your arteries. Why? Because plaque represents actual damage and "scarring" of the lining of your arteries. Keep in mind that blood supplied to your penis is done via the pudendal artery and you have actual penile arteries as well. Things simply are not going to work right in the bedroom if you have significant atherosclerosis. Meta-Analysis. All I can say for what these researchers concluded:

"Results Four trials, with a total of 390 patients, met our inclusion criteria. Two studies compared Hibiscus sabdariffa to black tea; one study compared it to captopril and one to lisinopril. The studies found that Hibiscus had greater blood pressure reduction but less than the ACE-inhibitors. However, all studies, except one, were short term and of poor quality with a Jadad scoring of <3 and did not meet international standards. The four randomized controlled studies identified in this review do not provide reliable evidence to support recommending Hibiscus sabdariffa for the treatment of primary hypertension in adults."

## CHAPTER 3

## LITERATURE REVIEW

### Hibiscus Sabdariffa

Hibiscus tea in Ghana is known as "Sobolo" with several reviews on its impact on hypertension and

cardiovascular health in generality. It is now very common to see hibiscus tea in the health stores and part of the health drinks of Ghanaians.

A recent 2019 study by Laikangbam *et al* investigated the acute impact of Hibiscus sabdariffa calyces (HSC) extract consumption on blood pressure (BP), vascular function and other cardiometabolic risk markers, concluded that, the extract of HSC improved postprandial vascular function and may be a useful dietary strategy to reduce endothelial dysfunction and CVD risk, although this requires confirmation.

A 2013 review by the University of Arizona found that hibiscus tea is used in 10 or more countries as normal treatment for hypertension without any reported adverse events or side effects — except in extremely high doses. The study led these researchers to state that “extracts of [hibiscus] are promising as a treatment of hypertension.” They did point out, however, that high-quality studies (known in the scientific community as the “gold standard”) are needed to see the specific interactions of hibiscus tea on high blood pressure according to Allison *et al.*[5]

Another 2010 study by McKay DL *et al.* [7] results suggest daily consumption of hibiscus tea, in an amount readily incorporated into the diet, lowers BP in pre- and mildly hypertensive adults and may prove an effective component of the dietary changes recommended for people with these conditions. A similar meta-analysis of RCTs showed a significant effect of H. sabdariffa in lowering both SBP and DBP by Serban *et al.* [11].

One significant study by Nwachukwu *et al.* [8], this time in Nigeria proved that, hibiscus tea is more effective than hydrochlorothiazide, a common blood-pressure lowering medication, at decreasing blood pressure. The most significant finding was that hibiscus tea, unlike its study counterpart, hydrochlorothiazide, did not cause electrolyte imbalance.

Hibiscus tea benefits go beyond blood pressure lowering. It could also help people with dyslipidemia cope with their cholesterol and high triglycerides level. These collective cardio disease risk factors are part of the greater cluster of symptoms known as metabolic syndrome, which could point to an elevated risk of diabetes and stroke. In one study by Gurorola *et al.* 2010 published in *Phytomedicine* [42], the researchers recommend the use of hibiscus extracts to naturally lower cholesterol and triglyceride levels in patients with metabolic syndrome.

Hibiscus tea’s capability to decrease high “blood lipids” also spreads to those with diabetes. For instance, a 2009 study by Mozaffari *et al.* had diabetes patients consume hibiscus tea twice a day for a month

and found a significant increase in HDL (“good”) cholesterol and decrease in overall cholesterol, LDL (“bad”) cholesterol and triglycerides.

Hibiscus tea also acts as a diuretic and it extends to the health of the renal system especially the kidneys. One animal testing by Laikangbam *et al.* 2012 suggests that hibiscus tea presents what is known as an “anti-urolithiatic property,” which means, it may lower the occurrence of compounds that form kidney stones. The investigators finally concluded that, HS tea be introduced in clinical practices and medicine in the form of orally administered syrup after further investigations and clinical trials

### 3.2 Red Palm Oil

High cholesterol is one of the major risk factors for heart disease. Too much of this fatty substance can build up in the arteries, which causes them to harden and narrow, forcing your heart to work harder to pump blood throughout the body. Some studies have found that red palm oil may actually help decrease the amount of bad LDL cholesterol in your blood to keep your heart healthy and strong. Palm oil has a superior nutrient profile that makes it useful for supplementation.

One study published in the *Journal of Nutrition* looked at the effects of palm oil, soybean oil, peanut oil and lard on cholesterol levels. Researchers found that palm oil caused a 13.1 percent decrease in bad LDL cholesterol and a 6.7 percent drop in triglyceride levels in those with normal cholesterol. The study was conducted by Zhang *et al.* 1997 titled Nonhypercholesterolemic effects of a palm oil diet in Chinese adults.

Another 2016 study out of Colombia showed that palm oil had a similar effect on blood cholesterol levels as extra virgin olive oil and was able to lower both triglycerides and LDL cholesterol. The study was conducted by Lucci *et al.* titled Palm oil and cardiovascular disease: a randomized trial of the effects of hybrid palm oil supplementation on human plasma lipid patterns, published in the journal *Food Function*.

A more recent study by Zulkipli *et al.* 2019 published in *PLoS One* titled Effects of palm oil consumption on biomarkers of glucose metabolism: A systematic review. The authors systemically searched PubMed, CENTRAL and Scopus up to June 2018. They searched for published interventional studies on biomarkers of glucose metabolism (defined as fasting glucose, fasting insulin, HOMA, 2-hour post prandial glucose and HbA1C) that compared palm oil- or palm olein-rich diets with other edible vegetable oils. The authors identified 1921 potentially eligible articles with only eight included studies. Seven randomized cross-over trials and one parallel trial were included. Study

population was among young to middle-aged, healthy, non-diabetic, and normal weight participants.

They concluded that current evidence on the effects of palm oil consumption on biomarkers of glucose metabolism is poor and limited to only healthy participants. “We conclude that little or no additional benefit will be obtained by replacing palm oil with other oils rich in mono or polyunsaturated fatty acids for changes in glucose metabolism”.

Other ways to lower cholesterol naturally and fast include eating more foods rich in omega-3 fatty acids, limiting your intake of sugar and refined carbs, and getting enough fiber in your diet.

### 3.2.1 Slows the Progression of Heart Disease

Besides lowering cholesterol levels, palm oil has also been shown to help improve the health of the heart by slowing the progression of heart disease. One study looked at the effects of palm oil on heart disease. After 18 months, 28 percent of people with heart disease who were treated with palm oil showed improvement while 64 percent remained stable. Conversely, no one in the placebo group showed improvement, and 40 percent actually got worse. The study was conducted by Tomeo *et al.* 1995 titled ‘Antioxidant effects of tocotrienols in patients with hyperlipidemia and carotid stenosis,’ published in the journal *Lipids*.

A two year study titled Palm oil antioxidant effects in patients with hyperlipidaemia and carotid stenosis-2 year experience by Kooyenga *et al.* 1997 published in the *Asia Pacific Journal of Clinical Nutrition*. The study investigated the antioxidant properties of a  $\gamma$ -tocotrienol and  $\alpha$ -tocopherol enriched fraction of palm oil, in patients with carotid atherosclerosis. Serum lipids, fatty acid peroxides, platelet aggregation, and carotid artery stenosis were measured over a 24-month period in 50 patients with cerebrovascular disease. The study revealed that, both antioxidant and placebo groups displayed significantly increased collagen-induced platelet aggregation responses ( $p < 0.05$ ) as compared with entry values. Serum total cholesterol, low density lipoprotein cholesterol, and triglyceride values remained unchanged in both groups, as did the plasma high density lipoprotein cholesterol values. Palm oil tocopherols appear to benefit the course of carotid atherosclerosis.

A more recent 2018 study review conducted by Ismail *et al.* titled Systematic review of palm oil consumption and the risk of cardiovascular disease. They systematically searched Central, Medline and Embase databases up to June 2017 without restriction on setting or language. They performed separate searches based on the outcomes: coronary heart disease and stroke, using keywords related to these outcomes and palm oil. They further searched for published

interventional and observational studies in adults. They concluded that, In view of the abundance of palm oil in the market, quantifying its true association with CVD outcomes is challenging. The present review could not establish strong evidence for or against palm oil consumption relating to cardiovascular disease risk and cardiovascular disease-specific mortality. Healthy diet and lifestyle are key to slowing the progression of heart disease. Besides including heart-healthy fats, like red palm oil, in your diet, getting enough exercise, eating plenty of anti-inflammatory foods and keeping your stress levels in check can also help reverse and reduce the risk of coronary heart disease.

### 3.3 Guava

Traditional folk medicine also uses parts of the guava plant to make things like guava leaf tea and extracts to use medicinally. Many of the folk recipes and treatments have been proven to be successful today. Here is specific health benefits based on how the fruit is used or consumed according to Gutiérrez *et al.* 2008 titled *Psidium guajava*: a review of its traditional uses, phytochemistry and pharmacology published Journal *Ethnopharmacology*.

Surprisingly, a serving of guava provides over 350 percent of the daily recommended amount of vitamin C, making it one of the best vitamin C foods. As a matter of fact, guava provides substantially more than an equal serving of oranges (87 percent DV).

Vitamin C has long been known for its immune system boosting benefits. As with other water-soluble vitamins, vitamin C does not get stored in the body, so it's imperative to reach the dietary goals to maintain the supply. An adequate level of vitamin C in the body can ensure the vitality of a number of body functions, including the immune system.

Vitamin C helps in the prevention of cell damage; thanks to its antioxidant qualities, which in turn helps prevent many diseases, even serious disorders like heart disease, arthritis and cancer. A 2012 study conducted by Javaria Gull *et al.* titled Variation in Antioxidant Attributes at Three Ripening Stages of Guava (*Psidium guajava* L.) Fruit from Different Geographical Regions of Pakistan published in Mdpi in Pakistan concluded that fully ripe guava had the most concentrated contents of vitamin C, so it's best to enjoy the mature fruit to get the best levels. The results also showed that different stages of maturation and geographical locations had profound effects on the antioxidant activity and vitamin C contents of guava fruit. Guavas contain several nutrients the body can't do without. In every 1-cup serving, 21 percent of the recommended dietary allowance (RDA) of vitamin A and 20 percent each of potassium (about the same amount as a banana) and folate.

Though this is very inspiring, it's the vitamin C that outshines the others to an overwhelming degree: Each serving imparts 628 percent of this bacteria-buster, so it's no surprise that it fights disease so powerfully. Guavas are even recommended for dengue fever according to StyleCraze 2016. The same serving size nets 20 percent of the RDA of folate, which is good for brain health and crucial for helping to ensure a healthy nervous system for unborn babies. Those nutritive benefits translate to the prevention and treatment of numerous diseases through improved immune function according to the healthsite 2016.

Traditional uses for guava over centuries included alleviating pain from toothaches and canker sores according to a 2014 study by K. Ravi and P. Divyashree titled *Psidium guajava*: A review on its potential as an adjunct in treating periodontal disease published in the journal *Pharmacognosy Review* and to help wounds heal when the juice is applied topically. Guavas were said to treat epilepsy and convulsions by making them less frequent.

### 3.3.1 Fibre in Guava Lowers Blood Pressure and provides Healthy Heart

The high potassium levels in guava fruit has been proven to naturally lower blood pressure and blood lipids according to a study by Singh *et al* 1993 titled Can guava fruit intake decrease blood pressure and blood lipids? Published in *Journal of Human Hypertension*. This study was a randomized, single-blind, controlled trial conducted to examine the effects of guava fruit intake on Blood Pressures and blood lipids in patients with essential hypertension, the study involved 145 hypertensives that entered the trial, 72 patients were assigned to take a soluble fibre and a potassium-rich diet containing 0.5-1.0 kg of guava daily (group A) and 73 patients to their usual diet (group B), while salt, fat, cholesterol, caffeine and alcohol intake were similar in both groups for four weeks. Potassium is one of the most important minerals in the human body, for it's an electrolyte and combats the negative effects of too much sodium, a common feature of the Western diet. High sodium intake leads to heightened blood pressure and, ultimately, heart disease.

In fact, potassium is crucial for healthy heart function. It also plays a part in reducing kidney stones, risk of stroke and bone loss in one 2004 report by Janice Hopkins Tanne titled Americans are told to reduce sodium and increase potassium intake published in *British Medical Journal*.

The report was based on a comprehensive review of the scientific literature and was sponsored by a number of US and Canadian governmental organizations and foundations. The report says unequivocally that blood pressure rises progressively as sodium intake increases. About 25% of Americans have

high blood pressure, and more than half of people aged over 60 do.

Healthy adults aged between 19 and 50 years should consume 1.5 g of sodium (equivalent to 3.8 g of salt) a day to replace losses through perspiration but should not exceed 2.3 g (5.8 g of salt), the report said. The upper limit should be lower in people aged over 50 and people with hypertension, diabetes, or kidney disease, because they are especially sensitive to the hypertensive effects of salt.

### 3.4 Saponin and Cardioprotection

According to one study by Sparge *et al.* [12], Vicken *et al.* [13], Saponins are high molecular weight amphiphilic compounds having triterpenoid and/or steroid aglycon as lipophilic moiety and sugars (usually glucose, rhamnose, glucuronic acid, arabinose, and xylose) as hydrophilic moiety. They are distributed in plants, fungi, and marine organisms such as starfish and sea cucumbers according to Obsbourn *et al.* [14], Gafri *et al.* [15]. Balandrin *et al.* [16] also stated that, the commercial importance of saponins came into existence in 1960 by the synthesis of sex hormone progesterone as a first oral contraceptive from diosgenin (derived from saponin named dioscin). According to Beepika and Prabir 2018 study, different pharmacological effects including antioxidant, antihypoxic, anoxia/reoxygenation, Ca<sup>2+</sup> ion regulation or calcium antagonist, cardiocyte apoptosis, vasodilatory effect, angiogenesis, inotropic and others have been compiled to explore the cardioprotective potential of saponins.

Although the saponins are one of the largest classes of plant natural products, their biological functions are not completely understood. They are generally considered to have important roles in defense of plants against pathogens, pests and herbivores due to their antimicrobial, antifungal, antiparasitic, insecticidal and anti-feedant properties according to Augustin *et al.*, [17]. Many plants synthesize and accumulate saponins during normal growth and development. The distribution of these natural products varies greatly among plant species, individual plants, organs and tissues, during development and maturation, and shows seasonal fluctuations. Some studies have suggested that variations in saponin distribution, composition and amounts in plants may be a reflection of varying needs for plant protection.

### 3.5 Tannins

Providing the background on Tannins, Caller *et al* 1986 stated that, Leather tanning has been used for centuries, even millennia, by immersing skins in water where special barks or woods containing tannin have been added. Up to a full year was necessary for leather to be produced in such a manner. However, the current tannin extraction industry is relatively newer. The more modern history of tannins began in the 17th century when Giovannetti, an Italian chemist, studied the

interactions between iron solutions and substances called “astringents”. In 1772, various researchers identified the presence of an acid in these compounds. This acid was then isolated by Scheele and turned out to be gallic acid. Based on the experiments of Deyeux and Bartholdi, continued by Proust in the late 18th and early 19th centuries, tannins have been officially recognized as a discrete group of different molecules based on gallic acid content. The great growth of the tannin extraction industry began in the years around 1850 in Lyon, where tannin was used as iron tannate for the black coloring of silk for women’s blouses. The name “tannin” comes from the use of this class of compounds in the tanning process of hides to give leather.

In a study by Pizzi *et al.* [18], Tannins are natural products found in higher plants. They are produced in almost all parts of the plant, namely seeds, roots, bark, wood, and leaves, because of their fundamental role in the defense of the plant against insects, food infections, fungi, or bacteria. The defense mechanism is based on the ability of tannins to complex proteins irreversibly. They are also considered as one of the effective components contributing to the fact that the risk of suffering from cardiovascular diseases and some forms of cancer can be reduced by choosing diets rich in fruits and vegetables. In addition to their documented effects on human health, tannins are also important for the welfare of ruminants; high protein feeds such as alfalfa trigger the production in the rumen of methane trapped as proteinaceous foam, resulting in a potentially mortal fermentation that can be reduced by adding tannin in the diet. Two wide classes of tannins exist: hydrolysable tannins such as gallo-tannins and ellagi-tannins, and condensed polyflavonoid tannins, these latter being stable and rarely subject to hydrolysis.

Tannins are known bactericides because they react with proteins irreversibly, thus complexing within bacterial membranes, neutralizing their activity. As a consequence, tannin-based pharmaceuticals to cure intestine infections have long-time been marketed. They have effective anticaries properties. Tannins also have many applications for other pharmaceutical/medical uses but all these are targeted for future use rather than the present.

In a study by Ricci *et al.* [19], Wine, beer, and fruit juices naturally contain tannins. The research stated that, it is actually their presence that accounts for their characteristic taste. In short, the level of tannin in any of these products must be within a definite interval/concentration range for the beverage to be organoleptically pleasing. Too low an amount of tannin and the beverage will be insipid and with no taste. Too high the proportion of tannins in the beverage and it is too unpleasant, too “tanning” for the consumer’s mouth. Many wines, some beers, and several fruit juices however contain too low a concentration of tannin and thus may need to be “doctored”. Initially, addition of

tannin or tannin-rich wood chips directly to wine to enhance its taste and give the impression of a wine of greater age was strictly forbidden in most European countries.

### 3.6 Reducing Sugars

A reducing sugar is a carbohydrate that is oxidized by a weak oxidizing agent (an oxidizing agent capable of oxidizing aldehydes but not alcohols, such as the Tollen’s reagent) in basic aqueous solution. The characteristic property of reducing sugars is that, in aqueous medium, they generate one or more compounds containing an aldehyde group.

Carbohydrases are classified according to their specificity toward natural glycoside substrates, that is, they are called cellulases, xylanases, mannanases, pectinases, chitinases, and so forth. More recent classification of glycoside hydrolases in families based on amino acid sequence similarities has been proposed by Henrissat in 1991 [20]. Many carbohydrases found extensive applications in biotechnology according to a study by Uhlig H in 1998.

Most of the methods for determination of carbohydrase activity are based on the analysis of reducing sugars (RSs) formed as a result of the enzymatic scission of the glycosidic bond between two carbohydrates or between a carbohydrate and a noncarbohydrate moiety. Different methods for assaying the RS have been applied in the carbohydrase activity measurements. A 2017 study by Rick *et al.* [21] suggests that efforts to reduce consumption of added sugars may result in significant public health and economic benefits.

### 3.7 Alkaloids

Any of a class of nitrogenous organic compounds of plant origin which have pronounced physiological actions on humans. They include many drugs (morphine, quinine) and poisons (atropine, strychnine). According to Hussain *et al.* 2018, the discovery of more compelling molecules that can halt the pathology of these diseases will be considered as a miracle of present time. Several synthetic compounds are available but they may cause several other health issues. Therefore, natural molecules from the plants and other sources are being discovered to replace available medicines. In conventional medicinal therapies, several plants have been reported to bestow remedial effects. Phytochemicals from medicinal plants can provide a better and safer alternative to synthetic molecules. Many phytochemicals have been identified that cure the human body from a number of diseases. The function of alkaloids in plants is not yet understood. It has been suggested that they are simply waste products of plants’ metabolic processes, but evidence suggests that they may serve specific biological functions. In some plants, the concentration of alkaloids increases just prior to seed formation and then drops off when the seed is

ripe, suggesting that alkaloids may play a role in this process. Alkaloids may also protect some plants from destruction by certain insect species.

Well-known alkaloids include morphine, strychnine, quinine, ephedrine, and nicotine. Alkaloids are found primarily in plants and are especially common in certain families of flowering plants. More than 3,000 different types of alkaloids have been identified in a total of more than 4,000 plant species.

The medicinal properties of alkaloids are quite diverse. Morphine is a powerful narcotic used for the relief of pain, though its addictive properties limit its usefulness. Codeine, the methyl ether derivative of morphine found in the opium poppy, is an excellent analgesic that is relatively nonaddictive. Certain alkaloids act as cardiac or respiratory stimulants. Quinidine, which is obtained from plants of the genus *Cinchona*, is used to treat arrhythmias, or irregular rhythms of the heartbeat. Many alkaloids affect respiration, but in a complicated manner such that severe respiratory depression may follow stimulation. The drug lobeline (from *Lobelia inflata*) is safer in this respect and is therefore clinically useful. Ergonovine (from the fungus *Claviceps purpurea*) and ephedrine (from *Ephedra* species) act as blood-vessel constrictors. Ergonovine is used to reduce uterine hemorrhage after childbirth, and ephedrine is used to relieve the discomfort of common colds, sinusitis, hay fever, and bronchial asthma.

Alkaloids are present in plant tissues as water-soluble salts of organic acids (tartaric, acetic, oxalic, citric, malic, and lactic acids), esters (e.g., atropine, scopolamine, cocaine, aconitine), or combined with tannins (*Cinchona* bark) or sugars (e.g., the glycoalkaloids of *Solanum* species) rather than as free bases. Alkaloids are naturally occurring compounds containing carbon, hydrogen, nitrogen, and usually oxygen and are primarily found in plants, especially in certain flowering plants. A single plant species usually comprises of few kind of alkaloids but numerous families of plants such as Solanaceae (nightshades).

Most alkaloids are isolated from plant matrices in the form of crystalline, amorphous, nonodorous, and nonvolatile compounds. However, low molecular weight alkaloids, such as arecoline and pilocarpine, and alkaloids with no oxygen atom in their structure (e.g., sparteine and nicotine) occur in the liquid form. Apart from the orange-yellow alkaloids berberine and colchicine, the red-colored betaine, the brick red sanguinarine, or the orange-colored canadine, the majority of alkaloids are colorless with a bitter taste. Indeed, quinine is still used as a bitter principle in tonic water.

### 3.8 Flavonoids

In nature, flavonoid compounds are products extracted from plants and they are found in several parts of the plant. A study by *Havsteen BH 2002* revealed that Flavonoids are used by vegetables for their growth and defense against plaques. They belong to a class of low-molecular-weight phenolic compounds that are widely distributed in the plant kingdom. They constitute one of the most characteristic classes of compounds in higher plants. Many flavonoids are easily recognized as flower pigments in most angiosperm families. However, their occurrence is not restricted to flowers but are found in all parts of plants as stated in a study by Dewick PM [22].

Flavonoids are also abundantly found in foods and beverages of plant origin, such as fruits, vegetables, tea, cocoa and wine; hence they are termed as dietary flavonoids. Flavonoids have several subgroups, which include chalcones, flavones, flavonols and isoflavones. These subgroups have unique major sources. For example, onions and tea are major dietary sources of flavonols and flavones.

Flavonoids play a variety of biological activities in plants, animals and bacteria. One study by Griesbach R *et al.* [23] revealed that, In plants, flavonoids have long been known to be synthesized in particular sites and are responsible for the colour and aroma of flowers, and in fruits to attract pollinators and consequently fruit dispersion to help in seed and spore germination, and the growth and development of seedlings.

Flavonoids are associated with a broad spectrum of health-promoting effects and are an indispensable component in a variety of nutraceutical, pharmaceutical, medicinal and cosmetic applications. This is because of their antioxidative, anti-inflammatory, anti-mutagenic and anti-carcinogenic properties coupled with their capacity to modulate key cellular enzyme functions. They are also known to be potent inhibitors for several enzymes, such as xanthine oxidase (XO), cyclo-oxygenase (COX), lipoxigenase and phosphoinositide 3-kinase as reported in a 1997 study by *Metodiewa et al. and Walker et al.* [24]

Flavonoids can be subdivided into different subgroups depending on the carbon of the C ring on which the B ring is attached and the degree of unsaturation and oxidation of the C ring. Flavonoids in which the B ring is linked in position 3 of the C ring are called isoflavones. Those in which the B ring is linked in position 4 are called neoflavonoids, while those in which the B ring is linked in position 2 can be further subdivided into several subgroups on the basis of the structural features of the C ring. These subgroups are: flavones, flavonols, flavanones, flavanonols, flavanols or catechins, anthocyanins and chalcones. Flavonoids have been ascribed positive effects on human and

animal health and the current interest is for disease therapy and chemoprevention. Currently there are about 6000 flavonoids that contribute to the colourful pigments of fruits, herbs, vegetables and medicinal plants

### 3.9 Coumarin

Coumarin was first isolated in 1820 by Vogel from tonka beans (*Dipteryx odorata* Wild; *Fabaceae* family) called also *Coumarou*, a vernacular French name. In one study by Aoyama *et al.* [25], Coumarins (2*H*-1-benzopyran-2-one) consist of a large class of phenolic substances found in plants and are made of fused benzene and  $\alpha$ -pyrone rings. Another study by Iranshahi *et al.* [26] stated that more than 1300 coumarins have been identified as secondary metabolites from plants, bacteria, and fungi. The prototypical compound is known as 1, 2-benzopyrone or, less commonly, as *o*-hydroxycinnamic acid lactone, and it has been well studied. Coumarins were initially found in tonka bean (*Dipteryx odorata* Wild) and are reported in about 150 different species distributed over nearly 30 different families, of which a few important ones are Rutaceae, Umbelliferae, Clusiaceae, Guttiferae, Caprifoliaceae, Oleaceae, Nyctaginaceae, and Apiaceae.

Evans 2009 stated that although distributed throughout all parts of the plant, the coumarins occur at the highest levels in the fruits (Bael fruits (*Aegle marmelos*). They are also found at high levels in some essential oils such as cassia oil according to Choi *et al.* [27] cinnamon bark oil, Bourgaud *et al.* [28] and lavender oil according to Rosselli *et al.* [29]. Bogdal D 1998 also of the views that environmental conditions and seasonal changes could influence the incidence of coumarins in varied parts of the plant. The function of coumarins is far from clear, although suggestions include plant growth regulators, bacteriostats, fungistats, and even waste products. Coumarins possess a variety of biological properties, including antimicrobial, antiviral, antiinflammatory, antidiabetic, antioxidant, and enzyme inhibitory activity. At least 1300 different coumarins have been identified. Coumarins have antithrombotic, antiinflammatory, and vasodilatory activities. Warfarin is the most popular one and it is used as an oral coagulant and rodenticide.

Coumarin and its heterocyclic derivatives exhibit beneficial and diverse biological activities, including, antitumor, antibacterial, anti-inflammation, inhibition of human carbonic anhydrase, and anticancer activity. Coumarins are also known for its lipid-lowering activity with moderate triglyceride-lowering activity. Furthermore, hydroxyl coumarins are considered as potent antioxidants and scavenge reactive oxygen species; thereby it can prevent free radical injury in the human body. Coumarins also can inhibit aromatase which could be useful in preventing the

emergence of menopause-related diseases, such as osteoporosis, increased risk of cardiovascular events/heart disease, and cognitive deficiencies. Coumarin is a compound of cinnamon that has been reported to possess pharmacological activity, such as anticancer, antibacterial and many others.

### 3.10 Plant Sterols

Plant sterols (phytosterols, phytostanols and their fatty acid esters) are cholesterol-like substances that occur naturally at low levels in fruits, vegetables, nuts and cereals. Most Australians consume between 150 and 360 milligrams of plant sterols naturally every day, depending on their diet. When eaten in higher amounts, between 2-3 grams per day, plant sterols can naturally reduce LDL cholesterol. High cholesterol is one of the major risk factors for heart disease. When eaten at the recommended amount, between 2 and 3 grams a day, plant sterols can reduce low-density lipoprotein (LDL) cholesterol (the bad cholesterol) levels in our blood. They do this by being cholesterol-like substances and are absorbed instead of LDL cholesterol. However, eating more than three grams per day does not reduce your LDL cholesterol any further. Food sources of PSS are vegetable oils, vegetable oil-based margarines, seeds, nuts, grain products, vegetables, legumes and fruits next to various food formats and food supplements with added PSt or one study by Ras *et al.* [30] proved that, Plant sterols or PStan. PSS intake from natural sources ranges between 200 and 400 mg/day with habitual diets and up to 600 mg with vegan- or vegetarian-type diets as proven in another study by Jaceldo *et al.* [31]. Higher intakes can only be achieved by consuming typical servings of food products enriched with PSS such as fat-based spreads and margarines or dairy-type foods like milk, yogurt and yogurt drinks. PSS contents of such foods are typically 0.75 to 2 g per serving size.

The LDL-cholesterol (LDL-C) lowering effect of PSS has been summarized in several meta-analyses based on a vast number of randomized, placebo-controlled clinical studies. The Katan *et al.* [32] meta-analysis forms the first landmark paper substantiating the LDL-C lowering effect of PSS. Another meta-analysis by Abumweis *et al.* [33] was published in subsequent years addressing a continuous dose-response relationship and the impact of the food format on the cholesterol lowering efficacy of PSS. The most recent meta-analysis by Ras *et al.* [30] included 124 clinical studies (with 201 strata) and over 9600 study participants. The average PSS intake was 2.1 g/day (range 0.2–9.0 g/day), and overall, a consistent.

### 3.11 Mango

A 2010 study by K. A. Shah, M. B. Patel, R. J. Patel, and P. K. Parmar published in the journal *Pharmacology Review* explains, "According to ayurveda, varied medicinal properties are attributed to different parts of mango tree." The research concludes,

“Studies indicate mango possesses antidiabetic, anti-oxidant, anti-viral, cardiogenic, hypotensive, anti-inflammatory properties,” and suggests additional research and further study to confirm the initial encouraging findings, which include the lowering of blood pressure and the management of diabetes. Mango leaves, which don’t always seem as appetizing as a juicy mango fruit, are now popularly consumed by preparing tea using mango leaf extract. Mango leaf tea can be found online, and fresh mango leaves can also be purchased online or in organic markets

### 3.11.1 Lowers Blood Sugar Levels

Rich in fiber plus an array of power-packed antioxidants, adding mango to your diet can have a big impact on blood sugar levels. For example, one study out of Oklahoma titled *Mango Supplementation Improves Blood Glucose in Obese Individuals* by Evans *et al.* 2014 published in the *Nutrition and Metabolic Insights* actually found that supplementing with mango for 12 weeks significantly reduced blood sugar levels in obese adults. This pilot study examined the effects of freeze-dried mango (*Mangifera indica L.*) supplementation on anthropometrics, body composition, and biochemical parameters in obese individuals.

The fiber in mangos may also help promote normal blood sugar levels as stated in one article published by Jillian Levy, 2017 titled *How to Maintain Normal Blood Sugar*.

Fiber passes through the gastrointestinal tract undigested, slowing the absorption of sugar in the process as revealed in a study titled *Effects of Dietary Fiber and Its Components on Metabolic Health* by James M. Lattimer and Mark D. Haub published in the journal *Nutrients* 2010. With three grams, or up to 12 percent of your daily fiber needs, in a single serving, enjoying mangos as part of a well-rounded healthy diet can support overall glycemic control.

### 3.11.2 Regulates Blood Pressure

Sometimes called “the silent killer,” high blood pressure affects an estimated 70 million American adults, and about one in five is completely unaware that he or she has it. High blood pressure places extra strain on the heart, forcing it to work harder to pump blood throughout the body so it can continue to work efficiently.

Mangos are rich in magnesium and potassium, which are two essential nutrients that are absolutely vital when it comes to regulating blood pressure as proven by Houston MC, Harper KJ 2008 study titled *Potassium, magnesium, and calcium: their role in both the cause and treatment of hypertension* published in the journal *Clinical Hypertension*(Greenwich). Plus, they’re also naturally low in sodium, a micronutrient that should be limited in those with high blood pressure according to one article titled *Dietary Salt Intake and*

*Hypertension* authored Sung Kyu Ha, M.D, in the journal *Electrolytes and Blood Pressure*.

### 3.11.3 Boosts Brain Health

Considered one of the best brain foods by Dr. Axe, mango nutrition is packed with vitamin B6, which is essential for maintaining brain function. In fact, some research suggests that a deficiency in this key vitamin could contribute to impaired cognitive function and neurological decline. This study *Vitamin B6 status, deficiency and its consequences--an overview* was published in the journal *Nutrition Hospital* by Spinneker *et al.* [34]. Vitamin B6 and other B vitamins are also crucial for maintaining the function of brain neurotransmitters and aid in supporting a healthy mood as well as regular sleep patterns. The study was also authored by David O. Kennedy titled *B Vitamins and the Brain: Mechanisms, Dose and Efficacy—A Review* in the journal *Nutrients*.

### 3.12 Coconut Oil

To date, there are over 1,500 studies to be accessed at <https://www.ncbi.nlm.nih.gov/pubmed/?term=coconut+oil> proving coconut oil to be one of the healthiest foods on the planet. Coconut oil uses and benefits go beyond what most people realize, as coconut oil — made from copra or fresh coconut flesh — is a true superfood. It’s no wonder the coconut tree is considered the “tree of life” in many tropical locations.

There’s no doubt that many people are confused about whether or not they should consume coconut oil regularly, especially after the American Heart Association’s (AHA) 2017 report on saturated fats titled *Dietary Fats and Cardiovascular Disease: A Presidential Advisory From the American Heart Association* led by Frank *et al.* The truth is that while the AHA’s recommendation to reduce saturated fats in your diet is reasonable, it doesn’t mean that people can’t consume any of it says Dr. Axe. In fact, the AHA recommends sticking to 30 grams per day for men and 20 grams per day for women, which is about 2 tablespoons or 1.33 tablespoons of coconut oil, respectively.

The spotlight is that, AHA did point out that we don’t have to completely avoid saturated fats, and that’s because we actually *need* it. It works to enhance our immune function and protect the liver from toxins.

And while the AHA is focused on how saturated fats may increase LDL cholesterol levels, we need to remember that coconut oil works to reduce inflammation naturally. Reducing inflammation should be everyone’s biggest health goal, as it is the root cause of heart disease and many other conditions.

So despite the hullabalo attached coconut oil in recent times, it plays an important role in reducing

inflammation, supporting cognitive and heart health, and boosting energy levels — this is just the few of the many coconut oil benefits.

### 3.12.1 Coconut Oil Nutrition

Thousands of studies have been conducted to reveal the hidden benefits of this amazing superfood: namely healthy fats called medium-chain fatty acids (MCFAs). These unique fats include:

- i. Caprylic acid
- ii. Lauric acid
- iii. Capric acid

About 62 percent of the oils in coconut are composed of these three healthy fatty acids, and 91 percent of the fat in coconut oil is healthy saturated fat. This fat composition makes it one of the most beneficial fats on the planet, as the USDA nutrient database proves. About 50 percent of the fat in coconut oil is lauric acid, which is rarely found in nature. In fact, coconut oil contains the most lauric acid of any substance on Earth. The body converts lauric acid into monolaurin, a monoglyceride that has shown to be somewhat effective in combating antibiotic-resistant staphylococcus and streptococcus.

Most of the fats we consume take longer to digest, but MCFAs found in coconut oil provide the perfect source of energy because they only have to go through a three-step process to be turned into fuel, as opposed to other fats that have to go through a 26-step process!

Interestingly, unlike long-chain fatty acids found in plant-based oils, MCFAs are:

- i. Easier to digest
- ii. Not readily stored as fat
- iii. Antimicrobial and antifungal
- iv. Smaller in size, allowing easier cell permeability for immediate energy
- v. Processed by the liver, which means that they're immediately converted to energy instead of being stored as fat
- vi. One tablespoon of coconut oil contains about 120 calories, 14 grams of fat, no fiber, no cholesterol and only trace amounts of vitamins and minerals.
- vii. The cardinal point here is that, it's the MCFAs present in coconut copra that makes it a true superfood, and it's why coconut oil health benefits are so plentiful and amazing.

### 3.12.2 Scientific Studies of Coconut Oil

According to medical research and the USDA nutrient database, coconut oil benefits the body in the following ways:

#### 1. Proven Alzheimer's disease Natural Treatment

The digestion of MCFAs by the liver creates ketones that are readily accessible by the brain for

energy. Ketones supply energy to the brain without the need for insulin to process glucose into energy.

Recent research by Nafar F and Mearow KM 2014 titled Coconut oil attenuates the effects of amyloid- $\beta$  on cortical neurons in vitro published in the journal Alzheimer Disease has shown that the brain actually creates its own insulin to process glucose and power brain cells. Also according to another research by Newport *et al.* 2015 titled A new way to produce hyperketonemia: use of ketone ester in a case of Alzheimer's disease published in the journal Alzheimer Dementia proved that As the brain of an Alzheimer's patient loses the ability to create its own insulin, the ketones from coconut oil could create an alternate source of energy to help repair brain function.

#### 2. Prevents Heart Disease and High Blood Pressure

Coconut oil is high in natural saturated fats. Saturated fats not only increase the healthy cholesterol (known as HDL cholesterol) in your body, but also help convert the LDL "bad" cholesterol into good cholesterols. A randomized crossover trial conducted by Chinwong *et al.* 2017 titled Daily Consumption of Virgin Coconut Oil Increases High-Density Lipoprotein Cholesterol Levels in Healthy Volunteers: A Randomized Crossover Trial published in *Evidence-based Complementary and Alternative Medicine* found that daily consumption of 2 tablespoons of virgin coconut oil in young, healthy adults, significantly increased HDL cholesterol. Plus, no major safety issues of taking virgin coconut oil daily for eight weeks were reported.

By increasing the HDL in the body, it helps promote heart health and lower the risk of heart disease. Coconut oil also benefits the heart by lowering high triglycerides.

#### 3. Treats UTI and Kidney Infection and Protects the Liver

Coconut oil has been known to clear up and improve UTI symptoms and kidney infections. The MCFAs in the oil work as a natural antibiotic by disrupting the lipid coating on bacteria and killing them. Research also by Otuechere *et al.* [35] titled Virgin coconut oil protects against liver damage in albino rats challenged with the anti-folate combination, trimethoprim-sulfamethoxazole published in the journal Basic Clinical Physiology Pharmacology shows that coconut oil directly protects the liver from damage.

Coconut water also helps hydrate and support the healing process. Doctors have even injected coconut water to clear up kidney stones. Coconut is a powerful superfood, which is evident given all of these tremendous coconut oil health benefits.

#### 4. Reduces Inflammation and Arthritis

In an animal study in India conducted by Vysakh *et al.* [36] titled Polyphenolics isolated from virgin coconut oil inhibits adjuvant induced arthritis in rats through antioxidant and anti-inflammatory action published in the journal International Immunopharmacology., the high levels of antioxidants present in virgin coconut oil (VCO) reduced inflammation and improved arthritis symptoms more effectively than leading medications.

In another recent study, coconut oil that was harvested with only medium heat was found to suppress inflammatory cells. It worked as both an analgesic and anti-inflammatory.

#### 5. Cancer Prevention and Treatment

Coconut oil has two qualities that help it fight cancer: one is the ketones produced in the oil. Tumor cells are not able to access the energy in ketones and are glucose-dependent. It's believed that a ketogenic diet could be a possible component of helping cancer patients recover.

And the second quality is the medium-chained fatty acid content in coconut oil. As the MCFAs digest the lipid walls of bacteria, they also can kill the helicobacter pylori bacteria that has been known to increase the risk of stomach cancer. This study was conducted by Wroblewski *et al.* [37] titled *Helicobacter pylori* and Gastric Cancer: Factors That Modulate Disease Risk published in the journal Clinical Microbiology Review.

Another, research by Lappano *et al.* [38] titled The lauric acid-activated signaling prompts apoptosis in cancer cells published in the Cell Death Discovery shows that lauric acid found in coconut oil may have anticancer actions by triggering anti-proliferation and pro-apoptotic effects.

#### 6. Immune System Boost (Antibacterial, Antifungal and Antiviral)

Coconut oil contains lauric acid (monolaurin), which has shown in a research by Shilling *et al.* [39] titled Antimicrobial effects of virgin coconut oil and its medium-chain fatty acids on *Clostridium difficile* published in the journal Medicinal Food., to reduce candida, fight bacteria and create a hostile environment for viruses. Many diseases today are caused by the overgrowth of bad bacteria, fungi, viruses and parasites in the body.

You can replace grains and sugar in your diet with coconut oil as your natural fuel source when you're sick. Sugar feeds the growth of bad bacteria. Instead, take one tablespoon of coconut oil three times daily when sick, and consume plenty of vegetables and bone broth as well.

#### 3.12.3 Coconut Water and Cardioprotection

Coconut water is a popular beverage now in Ghana with huge economic potential. It is dubbed "Mother Nature's sports drink," according to a WebMed article authored by Kathleen M. Zelman, MPH, RD, LD. Its Low in calories, naturally free of fat and cholesterol, more potassium than four bananas, and super hydrating -- these are just a few of the many benefits ascribed to Ghana's latest health craze: coconut water. No doubt there is a proposal for coconut sellers to wear special uniforms and also contribute to SSNIT. Ghana's coconut industry, according to organisers of the 2019 International Coconut Festival held in Accra, has a potential of earning the country 2.8 billion dollar worth of revenue annually. In 2017, Ghana was ranked 14th on the list of the world's top coconut producers, with 383,960 metric tonnes produced that year alone according to data from the Food and Agriculture Organization (FAO) Corporate Statistical Database.

Dubbed "Mother Nature's sports drink" by marketers, the demand is skyrocketing every corner in Ghana. There's no doubt that a tall glass of pure, organic coconut water is one of the most refreshing beverages you can enjoy, whether it's after a workout or simply to quench your thirst during a hot summer day.

In this research, you can learn more about coconut water, including its composition, where it comes from, its uses and benefits, and why it has become one of the most sought-after health beverages today.

#### 3.12.4 What Is Coconut Water?

The scientific name for coconut water is "coconut liquid endosperm" according to the Molecules 2009, 14, 5144-5164 — that is the clear liquid in the center of young, green coconuts and is made when the endosperm tissues of a coconut fruit go through nuclear mode of development, as described below in a Molecules journal 2009 study:

*"[T]he primary endosperm nucleus undergoes several cycles of division without cytokinesis (the process in which the cytoplasm of a single eukaryotic cell is divided to form two daughter cells). Cytokinesis then occurs, progressing from the periphery towards the center, thus forming the cellular endosperm layer.*

*At first, the cellular endosperm is translucent and jelly-like, but it later hardens at maturity to become white flesh (coconut meat). Unlike the endosperms of other plants (e.g., wheat and corn), the cellularization process in a coconut fruit does not fill up the entire embryo sac cavity, but instead leaves the cavity solution-filled."*

The "solution" described above is coconut water. It's described by WebMD, "The Truth About Coconut Water" as having a refreshing and nutty flavor. It's mildly sweet, but not overly so, unlike other fruit

juices available on the market. "The Encyclopedia of Healing Foods," 2010 also described it as astringent and mildly acidic when fresh, which is then lost as time goes by.

Today, Ghanaians are enjoying coconut water not just for its flavor, but also because of its superb health benefits. Coconut water is 95% water according to "The Encyclopedia of Healing Foods," 2010 but, at the same time, it offers a unique chemical composition that features vitamins, minerals, amino acids, natural sugars and phytohormones according to the Molecules 2009, 14, 5144-5164.

It contains electrolyte, very good ingredient. The liquid an ideal rehydrating drink, but the electrolytes in coconut water are also said to be similar to human plasma, which is why doctors have used uncontaminated raw coconut water intravenously, injecting it into the bloodstream to help avoid dehydration according to Naturopathic Doctor's Coconut Cure by Bruce Fife.

### 3.12.5 Coconut Milk versus Coconut Water

According to Dr. Mercola, Many people, usually those who are not accustomed to having coconut in their diet, often refer to coconut water and coconut milk interchangeably. But these two drinks are actually different. Coconut water is the raw, clear liquid — which develops naturally in the fruit — that you get when you open a fresh coconut.

Coconut milk is a manufactured product made by grating the coconut meat, adding water and squeezing out the juice. This results in a white and creamy liquid, not too different from dairy milk according to "Coconut Water for Health and Healing," 2017 by Bruce Fife. It is used in many ingredients, such as curry and sauces.

### 3.12.6 Health Benefits of Coconut Water

Drinking coconut water is something everyone should do as a form of clean water. Not only is it one of the best rehydration drinks available on the planet, the electrolytes and natural salts like potassium and magnesium plays an integral role in wellness, however, coconut water provides more nutrients that are beneficial to the body. Among these useful components are its cytokinins, a class of phytohormones that boast of antiaging, antithrombotic and anticarcinogenic effects, according to one study by Vermeulen K *et al.* [40] titled 'Antiproliferative effect of plant cytokinin analogues with an inhibitory activity on cyclin-dependent kinases published in the journal Leukemia and another 1994 study also conducted by Rattan SI and Clark BF titled 'Kinetin delays the onset of ageing characteristics in human fibroblasts' published in the journal Biochemical Biophysical Research Communication.

This liquid provides inorganic ions, B vitamins and minerals such as iodine, selenium, zinc and sulfur that all provide support for your antioxidant and overall system according to the Molecules.

### 3.12.7 Coconut Water Nutrition Facts

The liquid inside the coconut contains approximately 46 calories per cup, 10 grams of natural sugar, with little protein and zero fat. It contains multiple vitamins, minerals and phytochemicals that are ideal for human health according to Nutrition and You.com.

The primary nutrient in coconut water is potassium. It contains approximately 600 milligrams (12 percent daily value), making it a high electrolyte beverage. Coconut water also contains a small amount of sodium, about 40 milligrams and up to 10 percent of your daily calcium and magnesium needs according to Today's Dietitian.com

Electrolytes are critical to maintain blood volume, heart health, as well as to prevent dehydration. Maintaining electrolyte levels can help reduce fatigue, stress and help maintain muscle relaxation.

### 3.12.8 Scientific Studies on Coconut Water

- i. **Provides cardioprotective effects** — A 2003 animal study by P. Anurag and T. Rajamohan titled Cardioprotective effect of tender coconut water in experimental myocardial infarction published in the journal Plant Foods for Human Nutrition found that tender coconut water (TCW) may have cardioprotective effects as it helped decrease concentration of total cholesterol, VLDL + LDL- cholesterol and HDL cholesterol among rats that had induced myocardial infarction. The researchers noted that these benefits may come from the nutrients in the liquid, namely calcium, potassium, L-arginine and magnesium.
- ii. **May help boost kidney health** — Coconut water may reduce the risk of kidney stones. In a 2013 study by Gandhi M *et al.* titled 'Prophylactic effect of coconut water (*Cocos nucifera* L.) on ethylene glycol induced nephrocalcinosis in male wistar rat' published in the International Brazil Journal of Urology. Coconut water helped inhibit crystal deposits in renal tissues of rat subjects. It reduced the amount of crystals in their urine, as well. What's more, the researchers noted that this liquid "protected against impaired renal function and development of oxidative stress in the kidneys." They noted that it can be used for phytotherapy against urolithiasis. In 2018 studies by Kristina L titled Increasing Fluid Intake to Reduce Stone Recurrence Risk: Is More Technology Better? Published in The

- Journal of Urology, coconut water intake helped expel excess potassium, citrate, and chlorine from the body. This can cut down the risk of kidney stones. In addition to eliminating kidney stones, coconut water also cures bladder infections according to a 2017 study by J. N. Rukmini et al titled Antibacterial Efficacy of Tender Coconut Water (*Cocos nucifera* L) on *Streptococcus mutans*: An *In-Vitro* Study published in the Journal of International Society Prev Community Dent. This can be attributed to the antibacterial properties of coconut water
- iii. **May help in the management of diabetes** — Coconut water was found to have hypoglycemic and nephroprotective activities. Results of a 2015 study by Pinto et al titled Study of Antiglycation, Hypoglycemic, and Nephroprotective Activities of the Green Dwarf Variety Coconut Water (*Cocos nucifera* L.) in Alloxan-Induced Diabetic Rats published in the Journal of Medicinal Food revealed that rats given coconut water had better blood glucose maintenance compared to rats in the control group. According to the researchers:  
*“Our results indicate that CW has multiple beneficial effects in diabetic rats for preventing hyperglycemia and oxidative stress caused by alloxan.”* A separate 2015 study by Preetha et al. titled Mature coconut water exhibits antidiabetic and antithrombotic potential via L-arginine-nitric oxide pathway in alloxan induced diabetic rats published in the Journal of Basic Clinical Physiology Pharmacology. also noted that the L-arginine in coconut water is responsible for its antidiabetic and antithrombotic effects, and is mediated through the L-arginine-nitric oxide pathway. Diabetic rats that were treated with mature coconut water L-arginine had reduced concentration of blood glucose and hemoglobin A1c.
- iv. **Offers rehydrating effects after exercise** — A 2007 study by Ismail titled Rehydration with sodium-enriched coconut water after exercise-induced dehydration published in the Southeast Asian Journal of Tropical Medicine Public Health. Compared the rehydrating effects of water, coconut water and a sports drink. The authors noted that drinking coconut water is “as good as ingesting a commercial sports drink for whole body rehydration after exercise-induced dehydration but with better fluid tolerance” Even the World Health Organization recommends coconut water for treating dehydration – especially in cases of acute diarrhea <https://www.sciencedirect.com/> There is no direct relationship between coconut water and psoriasis. But coconut water can prevent dehydration, which can make your skin more vulnerable to issues like psoriasis (as dehydration prevents your body from eliminating toxins through your skin according to 2017 article by a staff writer at Minnesota School of Cosmetology. Coconut water is a healthy beverage. Most of its benefits are proven. Some aren't. But that doesn't have to stop you from consuming it, especially when it has an impressive nutritional profile.
- v. **Might Help Cure Hangovers:** There is less research on this too. Your body loses potassium when you consume excess alcohol. Coconut water helps replenish this electrolyte and might cure the horrible hangovers that usually follow.
- vi. **May protect against oxidative stress** — Coconut water is loaded with antioxidants that are known to help fight free radicals that may lead to oxidative damage. One study conducted by Manna et al 2014 titled Protective effect of coconut water concentrate and its active component shikimic acid against hydroperoxide mediated oxidative stress through suppression of NF-κB and activation of Nrf2 pathway published in the Journal Ethnopharmacology. found that shikimic acid (SA), an active phytoconstituent in coconut water, can help protect the liver cells of mice subjects, protecting them from hydroperoxide-mediated oxidative stress
- vii. **May help maintain healthy blood pressure levels** — A study by Alleyne et al. 2005 titled The control of hypertension by use of coconut water and mauby: two tropical food drinks published in the West Indian Medical Journal involving 28 hypertensive subjects looked at the potential effects of coconut water on blood pressure levels. Those who were given coconut water had significant decreases in their mean systolic and diastolic blood pressure. The high levels of potassium in coconut water may be a contributing factor to this benefit as well. Another 1998 study by Sacks et al. titled Effect on blood pressure of potassium, calcium, and magnesium in women with low habitual intake published in the Hypertension journal notes that this mineral has a “modest blood pressure-lowering effect.”
- viii. **May help maintain bone and teeth health, as well as muscle strength** — MedicalNewsToday notes that coconut water contains calcium, which is needed by your bones and teeth for repair, as well as magnesium, which not only brings potassium and calcium into the muscles for contraction and relaxation, but also helps with energy production and better organ function.
- ix. **May Be Useful For Blood Transfusions:** Coconut water can be used intravenously.

When extracted fresh from the fruit, the liquid is sterile and free of parasites, bacteria and germs. During the Vietnam War and World War II, it was infused into the bloodstream of patients whenever doctors had an insufficient supply of IV fluids. It's said to be similar in composition to human blood plasma. The intravenous use of coconut water is well documented. In a study by Campbell-Falck D *et al.* 2000 titled the intravenous use of coconut water published in the American Journal of Emergency Medicine., coconut water was used as a short-term intravenous hydration fluid for a patient from the Solomon Islands. Coconut water may mimic blood plasma. However, this effect may not last long. This is because of its sodium content – which is not high enough to stay in the bloodstream for long according to UFHealth Podcast. Also, the infusion of coconut water may cause the potassium levels to go up.

- x. **Might Strengthen Bones:** Coconut water is a good source of calcium to the Columbia University Medical Center. Hence, it may promote bone health.
- xi. **Cleansing / Detox:** Our bodies have an amazing natural ability to cleanse and detox on their own, if provided the correct nutrients and hydration. Inadequate hydration leads to the build-up of toxins in our bodies because the liver and kidneys, the detoxifying organs, are unable to function properly without adequate water. Dehydration resulting from water or electrolyte loss leads to fatigue, irritability, confusion and extreme thirst. These symptoms result from the inability for the kidney to adequately flush toxins out of the system. Adequate fluid intake, ideally 8–10 cups per day, can help prevent dehydration and maintain the body's natural detoxification ability. Although water is great, during very hot weather or strenuous exercise, more than just plain water may be necessary. Coconut water contains a similar electrolyte profile to human blood, making it an ideal beverage to replace fluids and help remove toxins from the body. The electrolyte potassium, specifically, can help counteract some of the negative effects of a high-sodium processed diet.

### 3.12.9 Drink Coconut water?

Aside from the benefits mentioned above, you'll be impressed to learn that this healthy beverage has culinary and cosmetic uses as well. Just like coconut milk and coconut oil, it's a very versatile product. Just take a look at these coconut water uses that you can try today:

- **Hair Health** — simply massages raw coconut water into your hair and comb through. Let dry under the sun, and then leave on for a few hours. Wash out

afterward according to Aromatherapy for Sensual Living: Essential Oils for the Ecstatic Soul," 2015

- **After-Shampoo Treatment** — Style Craze 2018 recommends diluting the coconut water with three to four mugs of tap water, and then using it as your final rinse to add shine to your hair.

**Skin Benefits** — If your skin is feeling taut and grimy, apply coconut milk squeezed from the grated pulp to your skin directly to cleanse and eliminate excess oil and dirt. This also gives it instant hydration according to the "Age Erase: Your Ultimate Beauty Bible to Ageing Gracefully," 2014. Coconut water has antibacterial properties, thanks to the lauric acid present in it according to Rukmini *et al.* 2017. These properties might help treat acne. Lauric acid was also found to exert the strongest bactericidal activity against *P. acnes*, the bacteria that promotes inflammatory acne according to Yang D *et al.* 2009 titled the antimicrobial activity of liposomal lauric acids against *Propionibacterium acnes* published in the journal Biomaterials.

- **Digestive Issues** — the potassium in coconut water may help with poor digestion. If you're suffering from constipation, coconut water and prunes can be mixed together to make an anticonstipation drink. Simply get a glass of hot water and soak the prunes in it for 10 minutes. Once soft, drain the water, allow the prunes to cool and then puree together with coconut water in a blender according to the "Coconut Water for Health and Healing," 2017
- **Culinary Uses** — Coconut water is delicious when ingested fresh from the fruit, but if you'd like to add variety to some of your other dishes, try replacing other fluids with this ingredient. From coconut water smoothies to vinaigrettes and even ceviche, it can have a plethora of uses in the kitchen.

### Take Home

- As the coconut matures, the liquid is replaced with coconut "meat." The greatest nutrient health benefits of coconut water come from drinking the water of the young coconut, not the mature coconut milk, which is generally lower in nutrients.
- In certain emergency situations, it has been used for IV hydration due to its high electrolyte content and the fact that it's sterile if used directly from the inside of the coconut
- **Reduce Stress and Muscle Tension:** It's almost as good as a massage! Some of the electrolytes found in coconut water, specifically calcium and magnesium, may help with stress and muscle tension. Many of us are missing these critical minerals in our diets, making stress management even more challenging. Other than maintaining strong teeth and bones, calcium helps with smooth muscle relaxation. Adequate calcium intakes may help keep our all our muscles relaxed, including our heart muscle, lowering the risk of

heart attacks according to Wu CC, Bohr DF 1991 titled Mechanisms of calcium relaxation of vascular smooth muscle published in the American Journal of Physiology.

- Magnesium has been nicknamed the “relaxation” mineral. Its primary function is in the parasympathetic nervous system, the part of the nervous system that helps us relax. It also helps with the formation of serotonin, the “feel good hormone” according to Weston Price Foundation. Magnesium and calcium work together to help maintain muscle relaxation. Coconut water contains both of these minerals, so drink up on a stressful day to help you stay calm and stress-free.
- *According to Dr. Axe: ‘if you cannot find a fresh, green coconut, your second best choice is cold-pressed coconut water, which is only lightly processed via high pressure processing instead of heat. This exposes the water to high pressure to eliminate bacteria, but maintains a greater level of vitamins and minerals. If coconut water does not need to be refrigerated, it usually means it has been pasteurized to maintain its freshness. During the pasteurization process, liquids are heated to a high temperature to kill any bacteria, but this also destroys many of the natural vitamins and minerals in the product. Avoid coconut water that is from concentrate. Generally, if any fruit or vegetable is made into a concentrate, it loses nutrients in the process — therefore, it is always best to choose options that are not from concentrate.*

## CHAPTER 4

# METHODOLOGY

## 4.1 Materials and Methods

### Toxicity Test

**Table-1: NOAL: No-Observable-Adverse-Effect Level**

S. NO	Species & Strains	No. of Animals	Route of Administration	Formulations & Dosages	Time of Deaths and Period of Observations	NOAL	Symptoms
1	Sprague Dawley rats	25 Male 5 groups (N=5)	Oral	Freeze-dried preparation 10, 30, 100, 300, and 1000 Mg/kg	No death occurred during the period of observation; 24h, and 30 days	>100mg/kg	Nil

### 4.1.2 Department of Pharmaceutics

#### MICROBIAL ANALYSIS OF DR. NYARKOTEY HERBAL TEA

Microbial Test Protocol-(BP Level of Microbial Contamination)

1. Assessment of total viable count of aerobic bacteria and fungi

Test for specific harmful organisms

The Doctor of Naturopathic Medicine researcher employed two different approaches to this research work. First, animal studies conducted at the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana-West Africa. Secondly, an observational study conducted on a hypertensive patient using an integrative approach to assess his condition

### 4.1.1 Department Of Pharmacology

#### Test Conducted: efficacy, Acute and Sub-Chronic Toxicity Test

##### Hypotensive Activity

The cat was anaesthetized using 1% w/v chloralose (80mg/kg, i.p). The femoral vein on one of the hind legs was isolated by dissection and fitted with a cannula. The arterial blood pressure was recorded through a carotid artery cannula via a pressure transducer and the phasic arterial pressure was continuously monitored via a universal oscillography. Effects of doses of acetylcholine (1x 10<sup>-8</sup>-1x10<sup>-1</sup>mg/kg) and Dr. Nyarkotey Herbal Tea (1- 1000mg/kg) on the arterial blood pressure was recorded. These effects were again recorded in the presence of atropine (1.2x10<sup>-6</sup>mg/ml). It should be noted that after each drug administration, cardiovascular variables were allowed to stabilize (in about 15 minutes) before any further administration of drugs were made. The venous catheter was continuously flushed with 0.5ml of 0.9% normal saline after each dose administered, this was to ensure that drug collected in the catheter were all pushed into the femoral vein. Each procedure described above was repeated four times. The doses of agonists and antagonists were chosen based on preliminary study in the lab at the Faculty of Pharmacy and Pharmaceutical Sciences-KNUST.

**Table-2: Level of microbial contamination**

<b>The total aerobic viable count of sample (BP 2015 Specification &lt;math&gt;&lt; 1 \times 10^5&lt;/math&gt; cfu/mL)</b>	<b>8.20x10<sup>1</sup> cfu/mL</b>
Test for <i>Escherichia coli</i> -MAC/37oC/48hrs (BP 2015 Specification-Nil/mL)	None detected
Test for <i>Staphylococcus aureus</i> -MSA/37oC/48hrs (BP 2015 Specification-Nil/mL)	None detected
Test for <i>Salmonella</i> spp.BSA/37oC/48hrs (BP 2015 Specification-Nil/ MI)	None detected
Test for <i>Pseudomonas aeruginosa</i> /PCA/37oC/48hrs (BP 2015 Specification-Nil/ MI)	None detected
Test for Yeast and Moulds-SB/25oC/5days (BP 2015 Specification)	6.10 10 <sup>1</sup> cfu/mL

#### 4.1.3 Department of Pharmaceuticals

**Table-3: Organoleptic Properties**

<b>Form</b>	<b>Tea bag</b>
<b>Colour</b>	<b>Wine</b>
<b>Taste</b>	<b>Acidic</b>
<b>Odour</b>	<b>Characteristic</b>

**Table-4: Physicochemical Properties**

<b>PH(1% warm aqueous ext.)</b>	<b>2.6</b>
Total alcohol-soluble extractive	not less than 33%
Total water –soluble extractive	<b>Not Less than 41%</b>
Moisture Content	not more than 12%

**Table-5: Phytochemical Properties**

<b>Reducing sugars</b>	<b>Positive</b>
Saponins	Positive
Tannins	Positive
Alkaloid	Negative
Flavonoid	Positive
Sterols	Negative
Coumarins	Negative

**Table-6: Chromatographic Profile**

<b>Stationary phase</b>	<b>silica gel</b>
Detecting reagent	Anisaldehyde
Sample used	Chloroformic extract
Mobile phase	chloroform Pet ether 9: 1

## 4.2 RESULTS

### 4.2.1 Findings

#### I. Department of Pharmacology

Dr. Nyarkotey Herbal Tea produced dose-dependent reduction in the arterial blood pressure of the anaesthetized cat comparable to acetylcholine. The depressor effects of acetylcholine and Dr. Nyarkotey Herbal Tea on the blood pressure of the anaesthetized cat were inhibited by 72.3 + 5.21% and 55.6 + 6.82% respectively, suggestive of muscarinic mediation. As per the findings, Dr. Nyarkotey Herbal Tea has hypotension effect and hence could be used in the management of hypertension. The OAEL is greater than five times the stated daily dosage (7.0ml/kg) indicated

by the manufacturer. The recommended dose is thus within the acceptable margin of safety.

#### II. Department of Pharmaceutics

The bacterial load obtained for the aerobic viable count was within the acceptable limit. The fungal load was within the acceptable limit (BP 2015). No harmful microorganisms were detected.

#### III. Department of Pharmacognosy

Three (3) spots Two (2) purple spots (R<sub>f</sub>= 0.25 and 0.37) One (1) violet spot (R<sub>f</sub>=0.81)

## 4.2 Observational Study Report

### 4.3.1 Study design

An observational study was conducted to study the effects of hibiscus tea with the brand name Nyarkotey Tea consumption on BP. The male patient aged 33yrs was made aware of the product and the treatment period. He was informed the purpose is to study the impact off the tea on his blood pressure for a day.

His pre systolic pressure was 180mmHg and diastolic pressure 120mmHg but not taking any pharmaceutical hypertensive drug.

### 4.3.2 Herbal product

The Hibiscus Sabdariffa tea was supplied by RNG Medicine Research Lab, Tema community 18, certified by the FDA for cardiovascular and general well-being. The dosage by the manufacturer reads two tea bags 3 × daily before or 30 minutes after meals. To be boiled in 500ml water for 5 minutes.

### 4.3.3 Measurement of BP

The male hypertensive patient aged 33years had pre systolic pressure 180mmHg and diastolic pressure 120mmHg. The systolic Blood Pressure and Diastolic Blood pressure were measured at the brachial artery by use of an automated BP device (OMRON) to enable the investigator assess the potency of the tea and also to avoid patient own readings and subjectivity. The first BP reading was measured prior to the administration of the tea and after the third dosage in the evening, it was also measured. The patient was monitored throughout the day at the Nyarkotey college of Holistic Medicine.

#### 4.4 Limitation of the Study

- i. This limited was conducted at the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi-Ghana, West Africa using animal models.
- ii. Observational study was conducted at the RNG Medicine Research Lab, Tema community 18, Tema, Ghana on a single patient.

## CHAPTER 5

### DISCUSSION

#### 5.1 Nyarkotey Tea

Hibiscus is a genus of flowering plants in the mallow family, Malvaceae. The genus is quite large, comprising several hundred species that are native to warm, subtropical and tropical regions throughout the world.

Hibiscus tea, otherwise known as roselle or sour tea, has many health benefits. One of the few that is actually supported by clinical trials is the impact of hibiscus tea on blood pressure. Hibiscus tea has been repeatedly shown to lower blood pressure in those with existing high blood pressure. Their blood pressure decreased around 10% systolic and 12% diastolic. The effect may be noticeable after just two weeks.

The most interesting findings from this observational study is that, one need to drink about 3 cups a day. However, this remedy is one that must be used continuously to maintain its positive results. For instance, when the same patient stopped the Tea in the same study for just three days, the blood pressure began to creep upward.

Nyarkotey Tea is the only non-drug, FDA-Certified for Cardiovascular Health and general well-being. It is formulated based on science and research. Nyarkotey Tea lowers blood pressure by relaxing constricted blood vessels which cause high blood pressure. It does so by harnessing the therapeutic power of slow paced breathing with prolonged exhalation in a way that is virtually impossible to achieve on your own.

Lab study conducted in Ghana at the Pharmacology Department of Kwame Nkrumah University of Science and Technology, Kumasi, Ashanti region, on efficacy showed the product Dr. Nyarkotey Herbal Tea produced dose-dependent reduction in the arterial blood pressure of the anaesthetized cat comparable to acetylcholine. The depressor effects of acetylcholine and Dr. Nyarkotey Herbal tea on the blood pressure of the anaesthetized cat were inhibited by 72.3+5.21% and 55.6 + 6.82% respectively, suggestive of muscarinic mediation.

The remarks states that, as per the findings, Dr. Nyarkotey Herbal Tea has hypotension effect and hence could be used in the management of hypertension. The No-Observable-Adverse-Effect level (OAEL) is greater than five times the stated daily dosage (7.0ml/kg) indicated by the manufacturer. The recommended daily dose is thus within the acceptable margin of safety.

The mechanisms for how hibiscus produces these benefits to blood pressure is revealed in the research by Obiefuna P *et al.* [10]. According to the paper, hibiscus increases the ability of blood vessels to relax (called “vasodilation”) Obiefuna P *et al.* [10] and also affects a frequent target of blood pressure medications, an enzyme in the kidney called angiotensin-converting enzyme [6] and Nwachukwu DC *et al.* [8].

None of the study animals died in the course of the study (Tab 1) and the level of the microbial loads were within the normal range (Tab 2). The Product has acidic taste (Tab 3) with PH of 2.6(Tab 4). The following phyto-ingredients were positive in the product analyzed: Saponins, Reducing sugars, Tannin and flavonoid (Tab 5). However, coumarins, sterols and alkaloids were negative (Tab 5)

#### 5.1.1 Naturopathic Cardiology in an observational study

This thesis reports case study of a 33year old man who was admitted at the Amrahia Health Centre at 10 am GMT with high blood pressure of systolic 203 mmHg and Diastolic of 130 mm Hg. The readings were further monitored every fifteen minutes after the Doctor administered the allopathic drugs. He was discharged to go home at 2 pm GMT, 2019. He combined the allopathic drugs (Amlodipine 10mg, Bisoprolol fumarate 10mg and Bendro-flumethiazide 2.5mg) prescribed to be taken once daily, 30 minutes after food with an herbal formula called Nyarkotey Tea approved by the FDA in Ghana for Cardiovascular Health and general well-being. The formula with the active ingredient Hibiscus Sabdariffa with other herbs blended synergistically together in a tea form was administered three times on that day and the following day. The allopathic drug was also taken once daily as prescribed by the Medical Doctor.

He reported to the Health Facility the following day at 2 pm GMT. His blood pressure was taken again and it fell to 131 mmHg and 86 mmHg respectively within 24 hour of administration. It is not understood, whether the stand alone allopathic drug or the herbal formula helps reduced the high blood pressure level. But, it is evident that, an integrated approach to his treatment helped further reduce high blood pressure within 24 hours by 72point at the systolic level which is significant and 44point at the diastolic level.

### 5.1.2 Body's natural response

It must be first understood that high blood pressure is a logical response of our body's intelligent control system. A reduction of blood flow (due to narrowed blood vessels and/or increased viscosity of blood) will lead to a deficiency of oxygen and energy to the cells and organs. To overcome this, our body elevates the blood pressure to maintain a sufficient supply of oxygen and energy to the cells and organs of the body. Drugs that are used to reduce the blood pressure do not overcome the circumstances that are causing the higher resistance to the flow of blood. On the contrary, they work against the efforts of our body to maintain a sufficient supply of oxygen and energy, in spite of harder circumstances. That's why one feels worse when taking those pills. The pills can't cure high blood pressure. But also comes with "side-effects", namely, dizziness, headache, fatigue, depression, throbbing of the heart, lack of energy, lack of concentration, impotency, frigidity and more.

The integration of allopathic, Complementary Alternative and traditional Medicine use in our modern health settings is something that the Medical Community and policy makers have to discuss in the treatment pathway. The major issue allopathic practitioners faced are the quality of training of Traditional and Alternatives Medicine Practitioners and integration. Also the safety and effectivity concern of CAM modalities is also another area of interest. However, one would also argue that, modern system of medicine today, also started from somewhere to get scientific foundation. Therefore, both practitioners should have open-minded approach to deal with their patients to improve quality of life care.

While there are many medications to lower blood pressure, both conventional and integrative medicine agree that the first line treatment for hypertension should be lifestyle changes. Some changes are straightforward; if you are smoker quitting is imperative or if you drink more than two alcoholic beverages a day reducing your intake is important.

Hippocrates had written that disease was both pathos (suffering) and ponos (toil), as the body worked to restore normalcy. The reason modern medicine has only concentrated on the toil is because fever, BP, sugar levels are measurable, while suffering is individual and internal. Raising blood pressure is the natural, intelligent, function of the body to cope with circumstances. But what could cause a permanent reset of the regulation system to a higher value of blood pressure as it happens in essential hypertension? Why would the body move away from the best value for blood pressure?

Perhaps the answer can be found in the work of Dr. Hans Selye. Selye postulated that sickness was an adaptive response. For example, a fever that raises

the core body temperature by 1 degree Celsius, costs the body an additional 13% energy. Suppressing a fever may save this additional expenditure, but the organism will fail in fighting off infection and may eventually die. However, to conserve this additional burden the body brings about behavioral changes such as huddling, making postural changes and seeking shelter. These are the subjective symptoms which are of little value in allopathic practice.

Selye coined the term syndrome of being sick to describe this stage of coping. This is the closest that one can come to explain the importance Homeopathy places on symptoms and sensations described by the patient. They go beyond the objective signs that laboratory tests will ever reveal. A practitioner of Homeopathy and Bach Flower Therapy is looking for these subjective symptoms to find a remedy. In the example given above, the fever is the objective symptom – the ponos described by Hippocrates. The description of pain, the amelioration caused by postural adjustment, the craving for warm drinks and aversions to cold drafts of air are part of pathos. How can we ever expect to find a remedy without taking pathos and ponos into account together?

From an exercise perspective, moving more is key. The recommended 30 minutes of moderate exercise like walking or biking can make an impact in your blood pressure reading.

Nutrition can have a large impact on your blood pressure and heart health. Diets like the Mediterranean diet which is abundant in fish, vegetables, fruit, good fats and whole grains has been proven to be beneficial at lowering your risk of heart disease. It is also recommended to decrease your sodium intake—best done by avoiding processed, canned and frozen foods. Foods like 70% or more dark chocolate and olive oil can be part of a heart healthy diet.

Managing stress and developing a consistent mind body practice is an essential tool in modulating blood pressure. While there are many medications to lower blood pressure, both conventional and integrative medicine agree that the first line treatment for hypertension should be lifestyle changes.

We must recognize the significance of both system of medicine and the role they both play and also understand and recognise that, Medicine is not competition; the patient is the captain of the ship and not the physician. The end result is improving quality of life care and not creating enmity among practitioners of CAM and allopathy. Time for integration!

### Hibiscus and Kidney Health

The development of urinary calculi or kidney stones is known as urolithiasis or nephrolithiasis. It is

considered one of the most painful conditions known to man. In industrialized countries, approximately 10-12% of the population will develop kidney stones. Over the last few decades, the incidence of kidney stones has increased and the age of onset for this condition has decreased. Diet and lifestyle may explain this phenomenon. Men (12%) are more likely than women (6%) to develop kidney stones and the first incidence of stones usually occurs between 20-40 years of age. The earlier the onset of the first episode, the more likely a person will be a multiple stone former. People of European descent are much more likely to develop stones than are Africans, African-Americans and Native Americans.

In people who have already had a kidney stone, approximately 50% will develop another stone within 5 years. Increased body mass (obesity) is also a significant risk factor for developing renal stones. There are 5 primary types of stones. The most common are calcium oxalate or calcium phosphate stones and they account for 80-85% of all stones. Diet (oxalate and phosphate consumption and excess sodium) may play a role in forming calcium stones, but lack of fluids and underlying metabolic problems such as hypercalciuria (excess urinary calcium), hyperoxaluria (excess urinary oxalate), and hypocitraturia (lack of urinary citrate) are most likely the primary causes. The development of urinary calculi or kidney stones is known as urolithiasis or nephrolithiasis.

### Science and Evidence?

It appears there is confusion between the term 'sciences' with 'evidence'. Science is, a way of thinking to allow us to best deduce how the world works around us. Evidence is the product of science (amongst other things). One is a useful tool. One is the product of that useful tool. For instance, Modern medicinal practice is 100% science based. It is however, not 100% evidenced backed, likewise, Engineering is 100% science based. Again, it is not 100% evidence backed.

In medicine, the importance of providing an evidence base (a specific kind of output of the scientific method) is of much more importance in other fields like engineering. Why? Because in engineering, physics, etc. the experimental evidence is much easier to produce (in theory) - you could design an experiment (even if only a thought experiment) that could prove/disprove your hypothesis with relative certainty and with little confounds or flaws in experimental design. In medicine, because of the vast amount of confounds and ethical issues (patient A vs patient B are different in thousands of different ways that could affect the validity of the experiment - it is never possible to recruit patients who are identical in every way) we use scientific and mathematical experimental techniques to minimize these confounds - the best of which is a double blind - RCT with good statistical analyses.

Thus, in both fields much of what is done is not directly evidence backed, but it is all scientifically backed.

### Example

If I was to give a patient 7.5mg of bisoprolol over 5mg of bisoprolol because I wanted to slow their heart rate more, this is not backed by evidence (i.e there is no trial to show 7.5 mg will reduce heart rate over 5mg) but it is backed by science - we know the receptor that bisoprolol acts upon, the inotropic and chronotropic effect this has on the adrenergic system, the volume of distribution of bisoprolol etc etc has all been proven. We know that increasing doses of bisoprolol has an inversely proportional relationship to heart rate. We know at what dose the receptor of bisoprolol will be saturated and this relationship no longer holds true. Often there is no need to produce evidence for situations like this. It does not mean that medicine is not scientific.

## CHAPTER 6

### RECOMMENDATIONS

Hibiscus tea is thought to be excellent for immune support, as it is extremely high in ascorbic acid, more commonly known as vitamin C. Vitamin C is a water-soluble vitamin that is responsible for keeping the immune system healthy and strong by assisting in the production of white blood cells. White blood cells have a serious job in the body and are responsible for fighting the pathogens and infections that sneak in. In addition, vitamin C promotes healthy skin and tissues and keeps the nervous system working.

Drinking hibiscus tea could also be helpful for patients suffering from anemia. Hibiscus tea is surprisingly high in iron. An 8-fluid-ounce serving (1 cup) delivers a whopping 20 milligrams of iron—an important mineral that keeps the immune system balanced and helps the body to maintain red blood cells (the carriers of oxygen around the body). The vitamin C naturally found within the hibiscus works to complement the iron, increasing its absorption. With the heaping amount of iron also come small amounts of minerals like potassium, magnesium, and zinc.

Hibiscus has also been shown to work as an antifungal agent. A study conducted in 2014 found that Hibiscus sabdariffa extract inhibits the formation of *Candida albicans*. *Candida albicans* is a type of yeast normally found in small numbers on the skin, or in the mouth, gut, or vaginal flora in about 15 to 60 percent of the population. It is considered a low-grade pathogen, but when there is candida overgrowth, it becomes a health concern. And there are limited therapeutic options available to treat candida overgrowth, which raises more concerns for those affected and for us as a global health community. It is essential to research and develop methods of prevention. Therefore, promoting

the application of natural plant-derived antimicrobials, like hibiscus, may be a good option for long-term prevention of these types of infections.

This thesis recommends that Nyarkotey Tea with hibiscus sabdariffa as the active ingredients could be used in the management of hypertension using integrative approach. Hibiscus Tea should also be embraced as one of the ingredients in any protocol for Naturopathic Cardiology.

## CHAPTER 7

## CONCLUSIONS

Nyarkotey Hibiscus tea provides solid results for increasing blood flow and lowering blood pressure as proven in both observational and animal studies and should be considered into blood pressure management. It should be considered also for men with erectile dysfunction in Naturopathic Urology. It should also be consumed regularly to help prevent atherosclerosis. Drinking hibiscus tea could also be helpful for patients suffering from anemia.



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