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Effect of 10% Pomegranate Juice on Lipid Metabolism and Body Fat in Rats

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DEDICATION

I would like to thank **God Almighty** who has given me the strength and courage to pursue my academic goals.

I want to dedicate this milestone to my parent **(Mr. Anthony Miezah and Mrs. Vida Miezah),** my siblings **(Antoinette Miezah, Michael Miezah and Anthony Miezah)** and members of my extended family for their continuous support and encouragement throughout my academic journey. I am so blessed to have you all.

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This achievement would not have been possible without each and every one of you.

VERONICA

DEDICATION

Above all, I would like to thank **God Almighty** for giving me the Strength, patience, and determination to perform this humble work.

To a man special and dear to my heart, for my support and strength in this life, for the one who sought my comfort and my success, for the one who instilled in me courage and patience, dear father: **Farid.** May God protect him and prolong his life.

To my paradise, to the source of my joy and happiness, the thread of hope that lights my way, my dear mother: **Djamila**. May God protect her and prolong her life.

To my strength in this life my brothers: **Islam, Haythem, Akram** who have always been by my side.

To my dear husband: **Sif Eddine** who gave me courage and moral support.

To all the members of my extended family

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To everyone who participated in my performance of this work

Finally, I pray that Allah accepts this effort and makes it of real benefit to all who read it.

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SAFA

DEDICATION

O **Allah**, praise be to you before you are satisfied, and praise be to you if you are satisfied, and praise be to you after satisfaction, we praise **Allah Almighty** and may he enable us to accomplish this humble work.

I dedicate this work to the face of **Allah**, may he be exalted, hoping that he will accept it and make it in the balance of my works.
And to our intercessor and beloved messenger of **Allah** (peace and blessings of Allaah be upon him).

To the one who shares my joys and pains, to the source of love and tenderness, to the greatest woman, my dear mother, **Souaad,** may God preserve her and prolong her life.

To whom my belonging to him and his remembrance make me proud, to the one who taught me the love of knowledge and instilled in me the spirit of responsibility and patience, to the one who sought my comfort and my succcess, to the greatest man in my life, my dear father, **Abdelmadjid**, may God protect him and prolong his life.

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ABBREVIATIONS

MetS : Metabolic Syndrome.

USDA: United States Department of Agriculture.

ROS: Reactive Oxygen Species.

NF-κB: Nuclear Factor kappa-light-chain-enhancer of activated B cells.

IκBα: nuclear factor of kappa light polypeptide gene enhancer in B-cells inhibitor, alpha.

HT-29: human colon cancer

cell line.

TNF: Tumor necrosis factor.

NO : Nitric Oxyde.

NOS : Nitric Oxyde Synthase.

NADPH: Nicotinamide adenine dinucleotide phosphate.

cGMP: cyclic guanosine monophosphate.

PSO: Pomegranate seed oil.

DSA : Directions des Services Agricoles.

LCAT: Lecithin Cholesterol Acyl Transferase

DGAT 1: Diacylglycerol O-acyl transferase

QX: Quintaux

SCFA: Short Chain Fatty Acids

PJ : Pomegranate Juice

HMG-CoA : Hydroxymethylglutaryl Coenzyme A

sGC- Soluble Guanylate Cyclase

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INTRODUCTION

Introduction

Pomegranate is a fruit-bearing plant that formerly belonged to the monogeneric Punicaceae family. It is native to Iran and surrounding regions, which are its primary center of origin. **(Rahimi *et al.*, 2012)**. Current phylogenetic studies classify pomegranate under the Lythraceae family (Flowering Plants) and this is due to its angiosperm phylogeny. The family contains one genus Punica, with two species: Punica granatum L. and P. protopunica Balf. **(Zeynalova *et al.*, 2017)**. Pomegranate has been cultivated and consumed by humans for about 5000 years. It was introduced to other parts of the world by various routes, such as trade, migration, and colonization. Pomegranate is now widely grown in Mediterranean, tropical, and subtropical areas. **(Chandra *et al.*, 2010)**

For many years, traditional medicine has employed pomegranates to cure a variety of illnesses. In several animal and human models, pomegranate fruit and bark are used to treat diarrhea, dysentery, and intestinal parasites. The juice and seeds have long been regarded as the most effective treatments for heart and throat conditions. **(Saeed *et al.*, 2018)**. Scientific and clinical research are particularly interested in its anti-hyperlipidemic, antidiabetic, and antihypertensive benefits. **(Vučić et *al.*, 2019).**

In recent years, pomegranate has been utilized to treat and prevent metabolic syndrome. Significant characteristics of metabolic diseases include imbalances in lipid metabolism. Various pomegranate fractions (peels, flowers, juice, and seeds) have been shown to regulate lipid metabolism in metabolic disorder-related diseases like dyslipidemia, atherosclerosis, etc, preventing the onset of illnesses in scientific studies. Pomegranate extracts are thought to regulate lipid metabolism in part because they reduce oxidative stress and the inflammatory response. **(Hou *et al.*, 2019)**

There have been 124 distinct compounds with varied health advantages found in pomegranates. Pomegranate polyphenols such as hydrolysable tannins, ellagic acid, punicalagin, and anthocyanins are some well-known phytochemicals. One of its key components with significant antioxidant action is ellagic acid. The red color of pomegranate juice is due to anthocyanins, which have also been found to have antioxidant potential. **(Heber *et al.*, 2011)**. Additional phytochemicals include carbohydrates, flavonoids, vitamins, amino acids, et cetera. These phytochemicals work on numerous cellular pathways and processes to produce their effects. For instance, polyphenols block prooxidative enzymes, scavenge free radicals, chelate transition metals, and prevent lipid peroxidation to carry out their antioxidation function **(Koleckar *et al.*, 2008)**. Vitamin C and E supplementation can influence serum cholesterol and triglyceride concentrations due to their antioxidant properties. They provide protection against oxidative stress-induced cellular damage by scavenging reactive oxygen species and by protecting proteins from alkylation through electrophilic lipid peroxidation products. **(McRae *et***

***al.*,2008; Traber *et al.*,2011)**. The NOS pathway is also how arginine exerts its anti-hyperlipidemic effects. That is, the enzyme NOS converts l-arginine to l-citrulline and nitric oxide. This nitric oxide which has a vasodilating impact and increases blood flow to tissues, helps to treat metabolic disorders including dyslipidemia. **(Khedara *et al*., 1999; Wu *et al.*, 2021)**

In view of the previous findings, there had been several assertions on which phytochemical compound in pomegranate juice is effective on lipid metabolism. However, little is known about amino acids, particularly arginine's effect on lipid metabolism. Our Study is aimed at understanding the bioactivity of arginine through the NOS pathway and subsequent activities of NO, and interpreting how this mechanism actively regulates lipid metabolism and as a result, opposes dyslipidemia specifically, hypercholesterolemia and hypertriglyceridemia and finally, decreases epididymal and perirenal adipose tissue weights.

1. Generality on Pomegranate

1.1. Pomegranate *(Punica granatum L.)*

1.1.1. Overview:

The Latin words pomum (which means "apple") and granatus (which means "seeded") were combined to create the English term pomegranate, which is a fitting name for the scarlet-red, tough-skinned fruit that contains the tasty, juicy arils (seed pulp) that have been a staple of human diets for thousands of years. The pomegranate plant, which may grow up to 5 to 8 meters tall, is a deciduous, fruit-bearing shrub or small tree, according to the New World Encyclopedia. Its oppositely positioned, lance-shaped, glossy green leaves have smooth margins and are placed on the stem. An average-sized pomegranate has 600 seeds total, each enclosed by an aril.

In ancient societies, the pomegranate fruit has been utilized for ages to both prevent and treat a wide range of illnesses. It is a rich source of phytochemicals such anthocyanins, ellagitannins, and hydrolysable tannins, which are responsible for its potent antioxidant and anti-inflammatory activities, and it demonstrates strong antioxidant activity**. (Sharma *et al.*, 2017).** Additionally, it contains a lot of flavonoids, alkaloids, punicic acid, fructose, sucrose, glucose, and simple organic acids.

Due to its ability to reduce inflammation and increase antioxidant activity, it can be regarded as a multifunctional medicinal and nutritional plant. As a result, it is used to prevent or treat risk factors for the metabolic syndrome (MetS). **(Laurindo *et al.*, 2022)**

Pomegranate has become a well-liked superfood as consumer demand for organic and healthy food products rises. Both consumers and food makers love it because of its adaptable flavor and potential health benefits.

1.1.2. Historical Origin

Punica L. is a feminine form of the old Roman term Carthage, which refers to the ancient city in northern Tunisia where the best Italian pomegranates originated and were transported to Italy. The pomegranate was once referred to as Malum punicum, or the Carthaginian apple. Linney then decided on the term that is in use today, adding the special adjective granatum, which means granular. As a result, its popular term in the US is "seedy apple."

J. Morton claims that the area extending from Iran to northern India is the pomegranate's native habitat. According to Mars and others, only a small portion of Iran is regarded as home. In present-day Central Asia, from Iran and Turkmenistan to Northern India, wild pomegranates are thriving.

Pomegranates are regarded as native to various areas. Vavilov asserts that the Middle East is where the pomegranate first appeared. Iran and its surroundings, as well as southwest Asia, were identified by A.P. Candolle, A. Goor, and J. Lieberman as the pomegranate's centers of origin. **(Zeynalova *et al.*, 2017)**

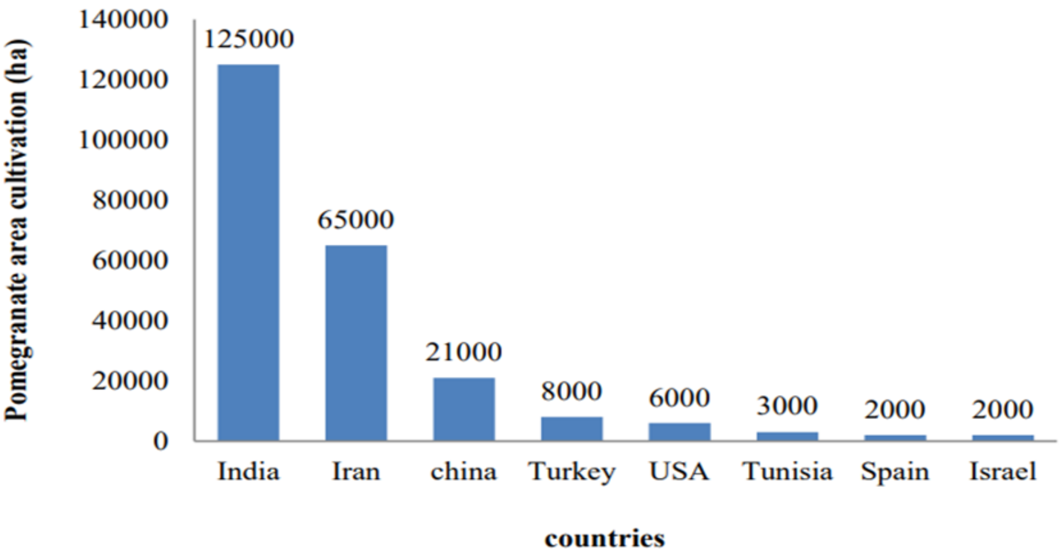


Figure 1: Pomegranate production area in the major producer countries in 2017. **(Moghaddam et al., 2019)**

1.1.3. Botanical Studies

Botanical Studies of pomegranate have revealed various insights about this unique fruit, including its taxonomy, morphology, genetics and phytochemistry.

1.1.3.1. Taxonomy

The taxonomy of pomegranate has been studied extensively, and its classification has been refined over time through morphological and genetic analyses. The pomegranate, Punica granatum, is placed in the flowering plant family Lythraceae. Previously, the genus Punica was placed in its own family of Punicaceae, but recent phylogenetic studies have shown that Punica belongs in Lythraceae, and it is classified in that family by the Angiosperm Phylogeny Group. The only other species in the genus, the Socotra pomegranate (Punica protopunica), is endemic on the island of Socotra. It differs in having pink (not red) flowers and smaller, less sweet fruit.

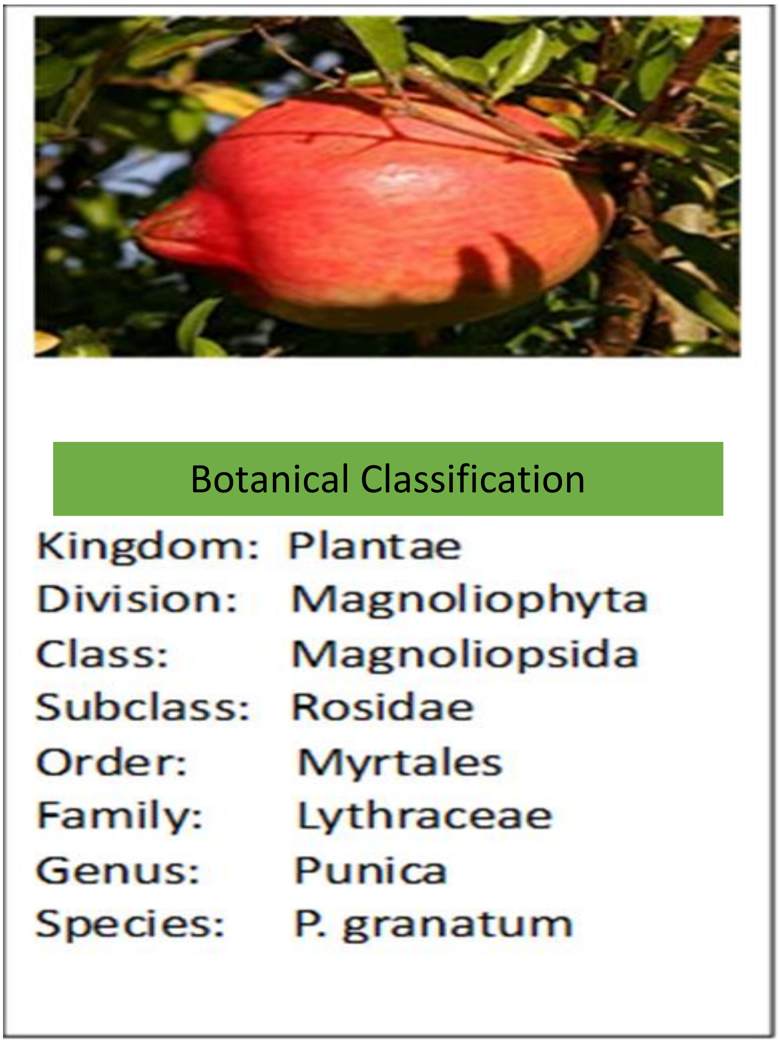


Figure 2: Classification of pomegranate **(kumari *et al.*, 2012)**

1.1.3.2. Genetics

In their 2018 study, Yuan Z et al. revealed a 274-Mb high-quality draft pomegranate genome sequence that comprises 30,903 genes, accounts for about 81.5% of the projected 336-Mb genome and is made up of 2177 scaffolds with a N50 size of 1.7 Mb. Pomegranate and Eucalyptus grandis both share the paleotetraploidy event, according to comparative analyses and phylogenomic evidence that it belongs to the Lythraceae family rather than the monogeneric Punicaceae family. Insights into the molecular mechanisms underlying the biosynthesis of ellagitannin-based compounds, the color formation in both peels and arils during pomegranate fruit development, and the ovule development processes that are distinctive to pomegranates were gained through integrated genomic and transcriptomic analyses. This genome sequence offers a valuable resource to deepen our understanding of some unusual biological processes and to support crop breeding and comparative biology research.

1.1.3.3. Morphology

The name pomegranate encompasses the tree and the fruit hence this section will give detail on the various parts of the tree and the fruit.

1.1.3.3.1. Pomegranate Tree

The pomegranate is a tidy, rounded shrub or small tree that typically grows to a height of 12 to 16 feet, though it can reach a height of 20 or 30 feet. It is typically deciduous, though in some places the leaves will remain on the tree. The trunk is covered in red-brown bark that later turns gray. The branches are stiff, angular, and frequently spiny. There is a strong propensity for them to sucker from the base. **(kumari *et al.*, 2012)**

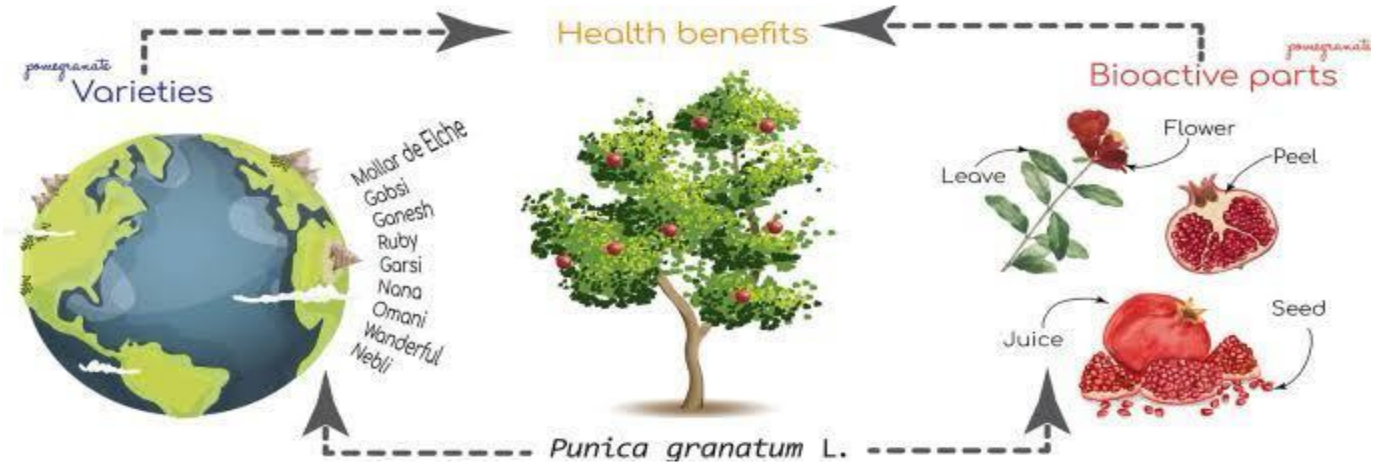


Figure 3: Pomegranate Tree **(Melgarejo *et al.*, 2021)**

a) Leaves

The leaves are opposite, 2.5-6.3cm long, oblong- unsubdivided, rectangular- elliptic or oblong – simple, glabrous, entire, circumstantially pellucide-punctate, shining higher than, bright inexperienced to a lower place base narrowed into a awfully short stalk. **(Haque *et al.*, 2015)**

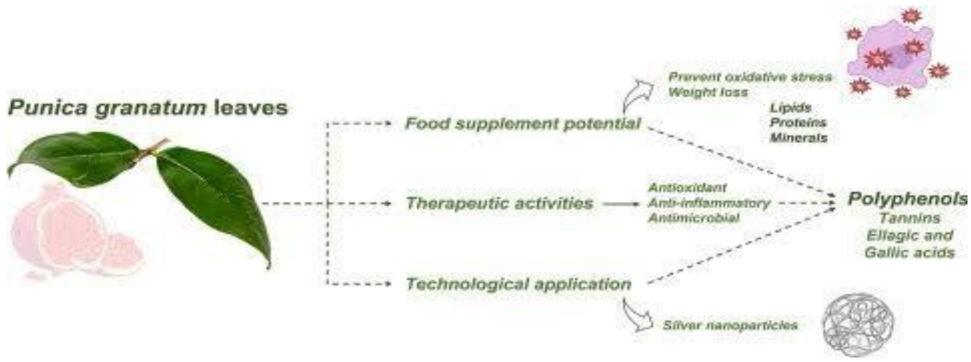


Figure 4: Pomegranate Leaves **(Janaina *et al.*, 2023)**

b) Flowers

The attractive scarlet, white or variegated flowers are over an inch across and have 5 to 8 crumpled petals and a red, fleshy, tubular calyx which persists on the fruit. The flowers may be solitary or grouped in twos and threes at the ends of the branches. **(Kumari *et al.*, 2012)**

Figure 5: Pomegranate Flower **(Kahramanoglu *et al.*, 2016)**

c) Bark and roots

According to an article from Chest of Books, Pomegranate bark is found in uneven, curled, or channeled pieces that are typically between 5 and 10 cm long and 1 to 3 cm wide; it hardly ever forms quills. Due to exfoliation of the outer layer, the root-bark has a rough exterior surface that is an earthy yellow color with darker spots and is characterized by conchoidal depressions. Smooth and yellow in color, the inner surface has sporadic deeper brown spots. It fractures with a very short fracture, the broken surface being virtually white and showing many fine tangential and even finer radial lines when viewed through a lens.

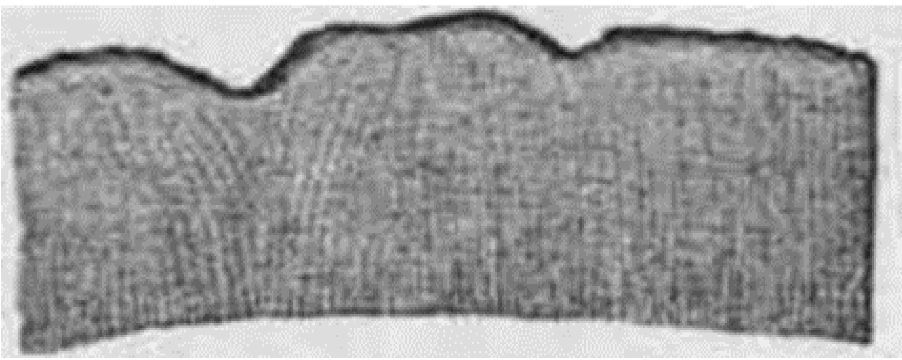


Figure 6: Pomegranate root-bark. Transverse section magnified.

1.1.3.3.2. Pomegranate Fruit

The fruit's size is in the range of an orange and a grapefruit; it has a rounded hexagonal form, a thick reddish skin, and about 600 seeds. The width ranges from 6 to 12 cm, and the weight is between 200 and 650 grams. **(Holland *et al.*, 2009 and Pande *et al.* ,2016).**

Figure 7: Pomegranate Fruit **(Chandrasekar et al., 2019)**

a. **Outer shell or skin:** The outer layer of the fruit is thick and relatively tough, and it protects the edible flesh and seeds inside. It is usually unappetizing and discarded before consumption.

b. **Arils:** The juicy, edible seeds of the fruit are known as arils. They are small, bright red, and surrounded by a translucent membrane. Arils are the most prized part of the fruit, and they can be eaten fresh or used in various recipes.

c. **Membranes:** Each aril is embedded within a white membrane that separates it from the other seeds. The membranes are not usually consumed, but they can be removed easily by cutting the fruit in half and gently separating them.

1.1.4. Types of Pomegranates

Even though there are different varieties of pomegranate, only a small number are involved in worldwide trade, according to **Cauchard *et al.*, 2013.** There is currently no evidence of a difference between the cultivars in terms of fruit size or agronomic traits. The following are the visible differences between each variety:

a. Skin tone: dark red to mild pinkish yellow.

b. The arils range in color from a very dark crimson to a clear pink.

c. The sour or sweet flavor of arils

The main varieties are referenced in this Table.

Table 1: Characteristics of the main pomegranate varieties **(Cauchard *et al.*, 2013)**

variety	External color	Aril color	Taste of arils
Wonderful	Dark red	Red	sweet/Acidic
Mollar de Elch	Pink/Yellow	Light red	Sweet
Herskowitz/Hershkovitz	Dark red	Light red	Acidic
Acco	Red	Red Dark	Sweet
Emek	Dark red	Red	Sweet/ Light Acidic
Baghwa	Light red	Light red	Sweet
Hicaz	Red	Light red	sweet/Acidic

1.1.5. Pomegranate Composition

1.1.5.1. Phytochemical composition of Pomegranate:

a. Juice and peel:

Fructose, sucrose, and glucose are all found in good amounts in pomegranate juice. Ascorbic acid, citric acid, fumaric acid, and malic acid are only a few of the simple organic acids that are present. Additionally, it also has various concentrations of each amino acid, particularly arginine, histidine, lysine, proline, methionine, and valine. Polyphenols are abundant in both the juice and the peel. The two main classes, tannins and flavonoids, suggest the pomegranate's medicinal potential due to its peculiar antioxidant and preservation properties**. (Newman *et al.*, 2007)**

b. Seed:

The oil made from pomegranate seeds (12–20%) is notable for having a high concentration of polyunsaturated fatty acids like linolenic and linoleic acids as well as other lipids like punicic acid, oleic acid, stearic acid, and palmitic acid. Pomegranate seeds contain proteins, crude fibers, vitamins, minerals, pectin, sugars, polyphenols, and isoflavones. **(Viuda *et al.*, 2010)**

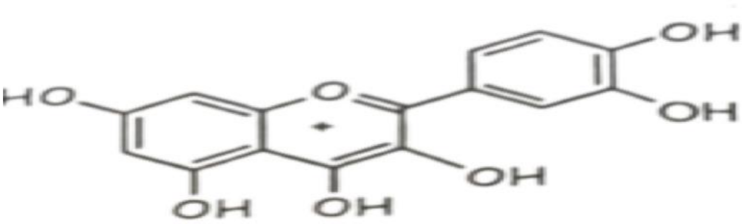
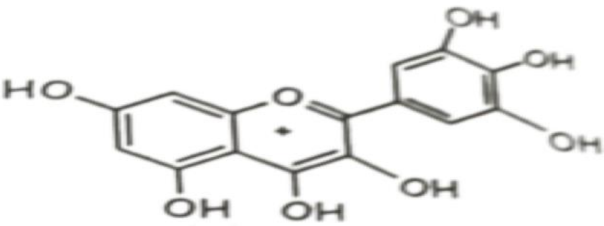
c. Aril:

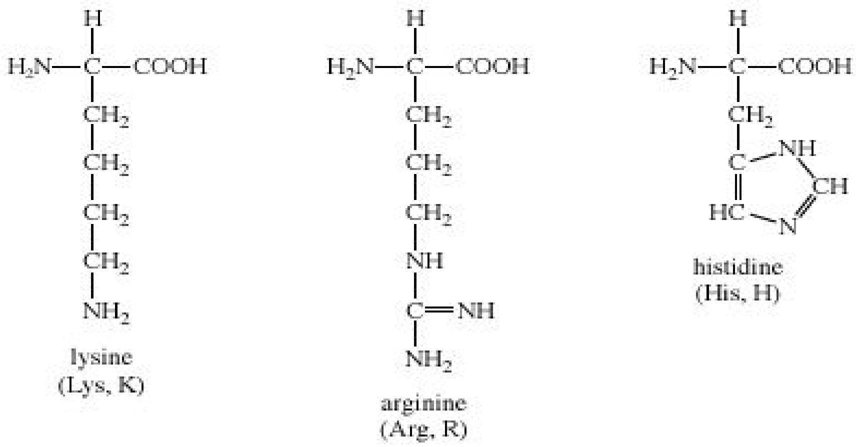
According to **Safa and Khazaei (2003),** the arils, or edible portion, makes up between 50 and 70 percent of the weight of a pomegranate. In addition to most of the substance being water (85%), it also contains bioactive substances such anthocyanins and other phenolic compounds, 1.5% organic acids, primarily ascorbic, citric, and malic acid, and 10% sugar, primarily fructose and glucose.

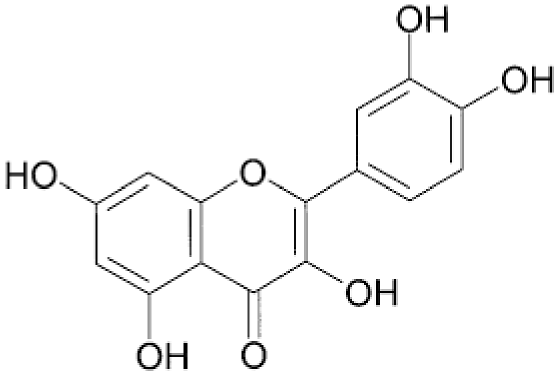
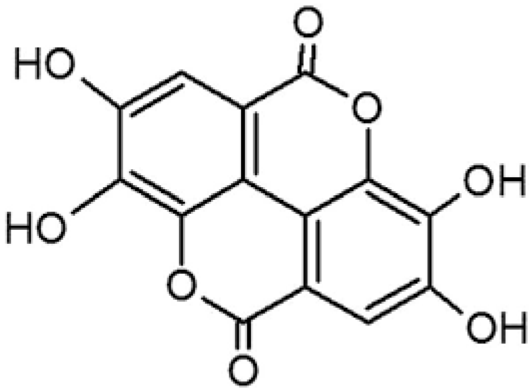
d. Bark and Roots

The pomegranate tree's bark and roots are rich sources of chemicals called alkaloids. They are carbon-based substances; they were used to treat worms in the human gastrointestinal tract in traditional medicine. **(Gil *et al.*, 2000).**

Table 2: Main constituents of the different parts of the pomegranate tree and its fruit

Components	Phytochemical Constituents
pomegranate juice	• Anthocyanins Examples: Cyanidin, Delphinidin, Punicalagin, etc.  Cyanidin **(Merghem, 2009)**  Delphinidin **(Merghem, 2009)**

	• Amino acids Examples: Arginine, Lysine, Histidine, Valine, Proline, etc. **(Newman *et al.,* 2007)**  Source: **Encyclopaedia Britannica** • Glucose, organic acid, ascorbic acid, gallic acid, caffeic acid, catechin, quercetin, rutin, minerals. **(Jaiswal *et al*., 2010)**
Pomegranate seed oil	Conjugated linoleic acid, linoleic acid, oleic acid, stearic acid, punicic acid, eleostearic acid, catalpic acid. **(Sassano *et al.,* 2009)**
pomegranate leaves	Fatty acids. **(Lan *et al.,* 2009)**
Pomegranate flower	Polyphenols Examples: Ellagic acid, Punicalin **(Aviram *et al.,* 2008),** Quercetin, Luteolin, Catechin, etc. **(Yisimayili *et al.,* 2019)**

	 Quercetin **(Wu *et al.*, 2003)**  Ellagic Acid **(Yalcin *et al.*,2018)**
Pomegranate Roots and Bark	Alkaloids Examples: Pelletierine, Pseudopelletierine and N-methylpelletierine **(Wu *et al.*, 2017)**

1.1.5.2. Nutritional Value and Chemical Constituents

Pomegranate is a fruit that is high in nutrients and low in calories compared to other fruits. It is a source of all the necessary and simple-to-digest nutrients, which revitalizes those who are mentally or physically exhausted. It is a diet rich in nutrition for young people, the old or ill, as well as expectant mothers. It has the ability to satiate thirst and heal hunger. **(Kushwaha *et al.*, 2013)**

a. Carbohydrate

A relatively good source of carbs is the pomegranate. 18.7 g of carbohydrates, all of which are sugars, are present in 100 g of pomegranate arils. Pomegranate is regarded as a fruit with a high GI. Pomegranate has a 10 g/100 g total sugar content, with glucose having the highest concentration (5 mg/100 g), followed by fructose. Also found in good proportions is sorbitol, which has a laxative effect (4.9 mg/100 g). **(Singh *et* Sethi, 2003).**

b. Fiber

With a fruit's typical fiber content, pomegranates are a medium source of fiber. Lignans and non-digestible carbs make up the fruit's 4 g/100 g of fiber. Fruit pectin (1.4%) is the main source of fiber. Pomegranate has about 0.64 and 0.18%, respectively, of soluble and insoluble dietary fiber. **(Melgarejo *et* Artes, 2000).** Dietary fiber can play an important role in the prevention of cardiovascular diseases. Indeed, soluble parietal fibers have a significant cholesterol-lowering effect, since they make it possible to reduce the level of LDL-cholesterol, hence considered as a risk factor for cardiovascular diseases. **(Brown *et al.*, 1999)** Soluble fiber is resistant to hydrolysis by small intestinal enzymes in humans but is fermented by bacteria to short-chain fatty acids (SCFA) in the large intestine. The production of SCFA leads to alterations in the intestinal microbiota, which contributes to the hypocholesterolemic effects of soluble fiber. **(Sun *et al.*, 2019).**

Table 3: Chemical composition of fresh pomegranate fruit. Source United States Department of Agriculture (USDA). **(Syed *et al.*, 2021)**

Constituents	Nutritive value per 100 g
Moisture	78.0%
Protein	1.67%
Fat	1.17%
Carbohydrates	18.7%
Fiber	4.0%
Calorific value	83 kcal
Vitamin c	10.2 mg
Thiamine	0.06 mg
Riboflavin	0.10 mg
Niacin	0.3 mg
Nicotinic acid	0.3 mg
Minerals	0.7%
Iron	0.3 mg
Phosphorous	36 mg
Choline	7.6 mg
Potassium	236 mg
Sodium	3 mg

c. Protein

Pomegranates contain a decent quantity of protein, unlike most fruits. Fruit has a 1.67% average protein content. The three main amino acids in pomegranates are aspartic acid, arginine, and glutamine, followed by glutamic acid and histidine. There are still additional amino acids present, though, including alanine, tryptophan, methionine, valine, phenylalanine, isoleucine, and lysine. Leucine and glycine are also found in trace elements. **(Kushwaha *et al.*, 2013)**

Table 4: Amino acids composition of pomegranate. **(Rowayshed *et al.*, 2013)**

Amino acid	**Percentage ((g/100 g)**
Histidine	0.22
Aspartic acid	0.30
Glutamic	0.52
Serine	0.11
Glycine	0.41
Arginine	0.23
Alanine	0.19
Proline	0.14
Lysine	0.19
Leusine	0.19
Isoleusine	0.1
Valine	0.14

d. Lipid

Pomegranates have minimal fat content (0.72 g/100 g of fruit weight). The fruit has 0.19 g of saturated triglycerides, with 0.14 g of unsaturated fats also present. Pomegranate arils contain 0.050 g/100 g and 0.048 g/100 g, respectively, of omega-3 (linoleic acid) and oleic acid. **(Fadavi *et al.*, 2006)**

e. Vitamins and minerals

In addition to providing tocopherol (vitamin E), an anti-sterility vitamin, pomegranates are a great source of the fat-soluble vitamin phylloquinone (vitamin K), which prevents clotting and hemorrhaging. Pomegranate also contains significant amounts of B complex vitamins, including pantothenic acid (vitamin B5) and folic acid (vitamin B9). Additionally, trace amounts of thiamine, riboflavin, and niacin are found. Pomegranates, in contrast to other fruits, have a relatively weak source of ascorbic acid. **(Kushwaha *et al.*, 2013).**

1.1.6. Production of Pomegranate

In addition to its global production, pomegranate is also widely grown in several regions of Algeria, particularly in Mostaganem, Tlemcen et cetera.

1.1.6.1. International production

The annual world production of pomegranates is estimated at around three million tons. The main producing countries of these fruits are India, Iran and China with a production of 900,000, 800,000 and 250,000 tons respectively **(Melgarejo *et* Valero, 2012).**

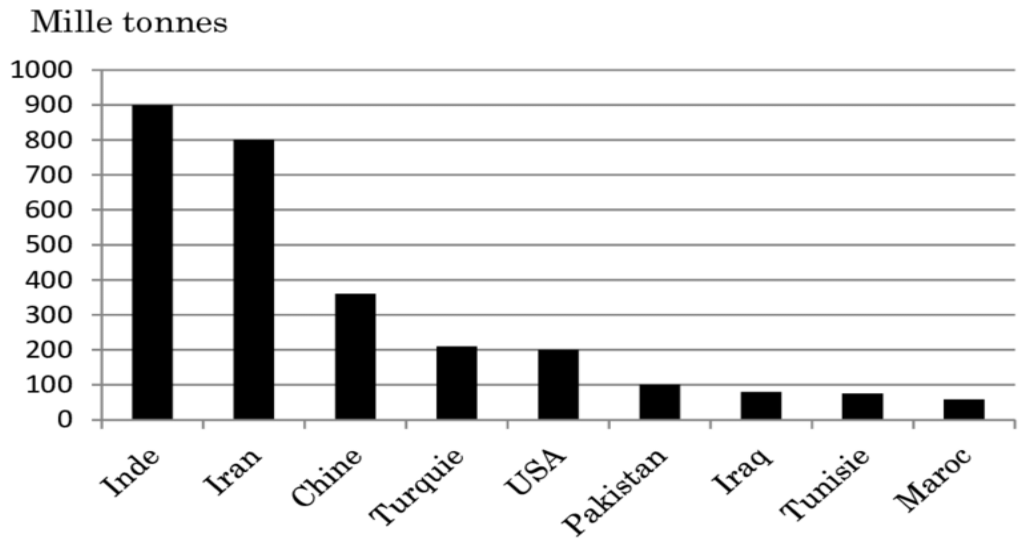


Figure 8: the largest pomegranate producing countries in the world. **(Melgarejo *et* Valero, 2012)**

1.1.6.2. National production

The pomegranate tree, a crop known for millennia in Algeria, and considered a secondary fruit species, has become increasingly important in recent years **(Kaci meziane, 2015).**

The production of pomegranate in Algeria as well as its area are recorded in the following table:

Table 5: Pomegranate production in Algeria **(DSA,2018)**.

	Planted Area (Ha)	Related Area (Ha)	Production (Qx)
Djelfa	1240	1186	110 760
Mostaganem	1140	1145	186 261
Relizane	723	705	90 565
M'sila	486	474	31 960
Tlemcen	444	205	1590

According to **DSA (Direction des Services Agricoles) in 2018,** the total pomegranate production in Algeria is 421,136 Qx. It should be noted that the state of Mostaganem records a large production with 186,261 Qx, followed by the state of Djelfa with 110,760 Qx. M'sila State ranks fourth in terms of pomegranate production with 31,960 Qx.

1.1.7. Current Uses

Due to the various benefits of pomegranate, it is applicable in various sectors as detailed below:

1.1.7.1. Culinary Uses:

Pomegranate juice, as well as the fruit itself, are used to make beverages, syrups, and cocktails.

Pomegranate juice, which is widely marketed in the United States since 2004, is a common beverage in the Middle East and is also utilized in Iranian and Indian cuisine, according to New World Encyclopedia. Syrian cooking makes use of pomegranate concentrate. Pomegranate juice is thickened and sweetened to create grenadine syrup, which is used to make cocktails. Grenadine was a common ingredient in many Persian dishes before the tomato was introduced to the region; it may still be found in classic dishes like fesenjan (a thick sauce made from pomegranate juice and ground walnuts, typically served over duck or other poultry and rice) and ash-e anar (pomegranate soup).

1.1.7.2. Medicinal Uses:

Pomegranate, or Punica granatum L, is one of the medicinal plants of the Mediterranean region that has been used for centuries to heal ulcers, diarrhea, and male infertility. Pomegranate has been found to have a wide range of pharmacological properties, including anti-diabetic, anti-tumor, anti-inflammatory, anti-malaria, anti-fibrotic, anti-fungal, and other benefits. Pomegranate consumption may enhance gut microbiota, preventing obesity and diabetes as a result. **(Maphetu *et al.*, 2022).**

Due to its great nutritional content, health advantages, and antioxidant bioactive ingredients, pomegranate fruit is regarded as a dietary medicine. It has been extensively used in herbal therapy to treat a variety of diseases, such as the flu and upper respiratory infections. **(Dhumal *et al.*, 2014).**

1.1.7.3. Cosmetic Uses

One of the oldest fruits, the pomegranate (Punica granatum), has a remarkably wide range of ethnomedical uses. The seeds are renowned for bestowing invulnerability in battle and enhancing beauty and fertility, while the peel (pericarp) is widely known for its astringent effects. Human epidermal keratinocyte and human dermal fibroblast activity was tested in this study using aqueous fractions made from the fruit's peel, fermented juice, and seeds, as well as lipophilic fractions made from pomegranate oil. Skin healing is aided by these outcomes. In other words, the seed oil and peel of the pomegranate are effective in promoting epidermal and dermal regeneration. **(Aslama *et al.*, 2006).**

1.2. Biological Properties of Pomegranate and its Health Benefits

The phytochemical components of pomegranate make it useful in biological mechanisms and as a result, provide several health benefits to the system:

1.2.1. Anti-oxidative effect

Pomegranate extract has strong antioxidant capacities linked to the presence of polyphenols such as anthocyanins, ellagic tannins and hydrolysable tannins (**Edeas, 2010).** The antioxidant power of pomegranate phenolic compounds is related to punicalagin isomers, ellagic acid derivatives and anthocyanins (delphinidin, cyanidin, pelargonidin 3-glucosides and 3,5-diglucosides). **(Soobrattee *et al.*, 2005).** Antioxidant activity of polyphenol is exerted by the inhibition and deactivation of free radicals, chelation of traces of metal ions responsible for the production of ROS, inhibition of prooxidative enzymes and lipid peroxidation. **(Koleckar *et al.*, 2008).** Polyphenols can inhibit prooxidative enzymes through several mechanisms and one of it is by binding to the active site of the enzyme, which can prevent the enzyme from catalyzing oxidation reactions. Examples of these enzymes are xanthine oxidase and lipoxygenase as they produce free radicals. Polyphenols can also chelate transition metal ions such as iron and copper, which are required for the activity of some prooxidative enzymes. By removing these metal ions, polyphenols can reduce the activity of the enzymes. Additionally, polyphenols can also act as reducing agents, donating electrons to free radicals and neutralizing them before they can react with and activate prooxidative enzymes**. (Leci *et al.*, 2014; Kicel *et al.*, 2018).** Polyphenols inhibit lipid peroxidation by the prevention or delay of lipid oxidation, and this is due to their strong hydrogen-donating potential and ability to chelate transition metal ions. By donating hydrogen atoms to free radicals, polyphenols can neutralize them and prevent them from reacting with and damaging lipids**. (Wu *et al.*, 2022).**

1.2.2. Anti-inflammatory effect:

pomegranate can prevent and treat various inflammation-driven diseases through the inhibition of the NF-κB signaling pathway. NF-κB is a transcription factor that plays a key role in regulating the immune response to infection and inflammation. Pomegranate can prevent the degradation of IκBα, an inhibitor of NF-κB, and hinder the translocation of NF-κB from the cytosol to the nucleus. This can reduce the expression of pro-inflammatory genes and decrease inflammation. **(Mandal *et al.*, 2017).** Pomegranate juice's anti-inflammatory effects on the signaling proteins in the HT-29 human colon cancer cell line have been documented by **(Adams *et al., 2006).*** With a pomegranate extract concentration of 50 mg/L, reductions in p65 NF-B subunit phosphorylation, binding to the NF-B response, and 79% suppression of TNF- protein expression have been noted.

1.2.3. Vasodilating effect:

The amino acid components of pomegranate are affiliated with lipid lowering effect and this is significantly due to L-arginine which is a substrate for NO synthesis. NO regulates cell function and communication in various physiological and pathophysiological pathways. It has several health benefits such as the amelioration of metabolic syndromes (including dyslipidemia, hypertension, obesity, et cetera) and treatment of sickle cell disease, pre-eclampsia and muscular dystrophy**. (Wu *et al.*, 2021).** As the quantity of endogenous arginine is limited, most arginine is obtained through dietary supplementation like it is in the case of pomegranate juice. Once arginine is absorbed, it is converted through the NOS pathway. The chemical reaction of this pathway involves the oxidation of L-arginine to produce NO and L-citrulline. This reaction is catalyzed by NOS, which transfers electrons from NADPH to the heme group of the enzyme. The heme group then binds and activates molecular oxygen, which reacts with L-arginine to produce NO and L-citrulline **(Stuehr *et al.*, 2004).** Once NO is produced, it goes through the sGC-dependent relaxation pathway where it is diffused into the smooth muscle cells that line blood vessels and activating an enzyme called guanylyl cyclase. This enzyme produces cyclic guanosine monophosphate (cGMP), which causes the smooth muscle cells to relax, leading to vasodilation and increased blood flow. **(Jin *et al.*, 2010).**

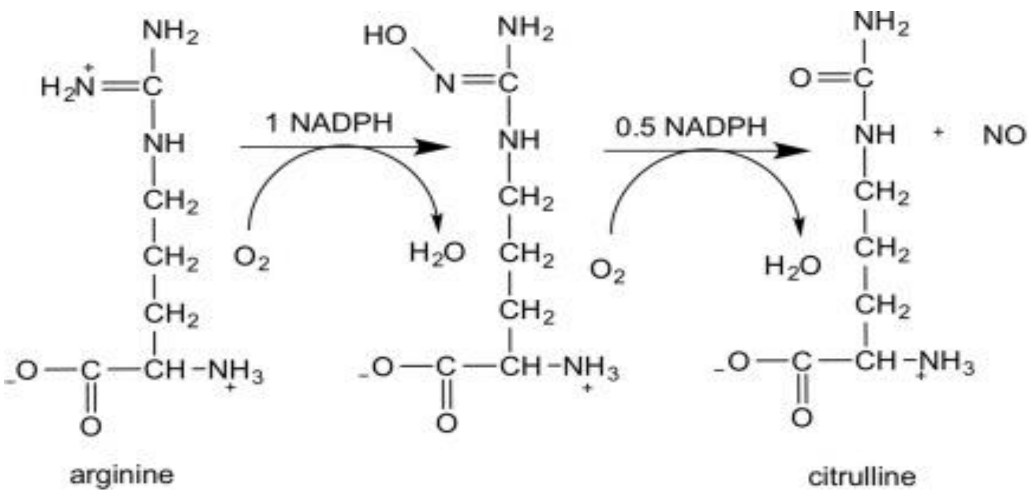


Figure 9: Conversion of l-arginine to l-citrulline and NO by NOS**.**

(Colette *et al.*, 2018)

1.2.4. Anti-Hyperlipidemic Effect:

Relating to the vascular function of NO produced from l-arginine which is a phytochemical from pomegranate, once the blood vessels are dilated and blood flow to the tissues increases, it can facilitate the transportation of LDL-C to the liver where it is metabolized. This mechanism is equally appropriate in reducing lipid levels, especially bad cholesterol. Pomegranate seed oil (PSO) contains punicic acid, a type of conjugated fatty acid that has been shown to have anti-atherogenic effects 1. In a double-blind placebo-controlled clinical trial, hyperlipidemic subjects who received 400 mg of PSO twice daily for 4 weeks showed significant decreases in their mean concentration of TAG and the TAG: HDL cholesterol (HDL-C) ratio compared to baseline values. The treatment effect was statistically significant in the PSO group compared to controls in reducing the cholesterol: HDL-C ratio. These findings suggest that PSO may have anti-hyperlipidemic effects by improving lipid profiles. **(Mirmiran *et al.*, 2010).**

MATERIAL AND METHODS

2. Material and methods:

2.1. Animal and Diets

Male *Albino Wistar* rats, obtained from animal house (Animal Biology Department, University of Brother's Mentouri, Constantine 1), weighing 80-100g were used. They were individually housed in well-ventilated metal cages. Room temperature was kept at 18-24 °C on a 12 h light-dark cycle (light on 8:00AM to 20:00 h). Rats were fed poor diet, in a two-ways design, Control group and 10% pomegranate juice group. The pomegranate fruits used for the experiment were obtained from Tlemcen.

2.2. Experimental Procedure

Rats were divided into two groups of 6 rats each, Control group (C) and 10% pomegranate juice (PJ) group with similar mean body weights. The two groups were fed the same poor diet whiles the water of the experimental group was replaced with 10% fresh pomegranate juice. Juice was prepared daily by weighing 100g of pomegranate arils, blending and sieving the juice after which it was diluted with water to a 1000ml mark of a measuring cylinder and subsequently transferred into a volumetric flask. This total volume was shared amongst the six experimental rats with 150ml per each rat. After 5 weeks of consuming diets, food was removed from the metal cages at 07:30 h and rats were lightly anesthetized with chloroform and killed between 11:00 h and 14:00 h. Blood was collected by heart puncture using portal vein sampling and they were allowed to clot on ice. Serum samples were obtained by centrifugation (3000 rpm for 20 min). Abdominal adipose tissues (Epididymal and perirenal adipose tissues) and liver were immediately removed, weighed and stored at -20°C until use.

Figure 10: Pomegranate Juice Preparation **(Original)**

2.3. Analytical Procedure:

Serum stored were used in biochemical tests for total cholesterol, triglycerides, creatinine with kits from BIOMAGHREB, CEBIO and BIOLABO. All tubes were correctly labelled before laboratory tests begun. These tests were conducted at EPSP (Établissement Public de Santé de Proximité) polyclinic with all protocols strictly followed.

2.3.1. Quantitative test for Total Cholesterol:

- **Principle:**

The cholesterol level is measured after enzymatic hydrolysis and then oxidation. The quinonimine indicator is formed from hydrogen peroxide and amino 4 antipyrine in the presence of phenol and peroxidase according to the following reactions:

$$\text{Cholesterol esters} + H_2O \xrightarrow{\text{cholesterol esterase}} \text{Cholesterol} + \text{Fatty acid}$$

$$\text{Cholesterol} + O_2 \xrightarrow[\text{Peroxidase}]{\text{cholesterol oxidase}} \text{Cholestene-4-one-3} + H_2O_2$$

- **Procedure**

Using BIOMAGHREB testing kit, 14 labelled tubes were fixed into a tube rack where the first was for the blank reagent tube, the second was for the standard tube and with the remaining 12 tubes, six were for the control group tubes and other six for the PJ group tubes. 1000microlitres of the already prepared cholesterol reagent was measured into each of the labelled tubes. 10microlitres of the standard serum was added to the standard tube and same was done for the control group(C) and experimental group (PJ) sera. The tubes were then incubated in water-bath at 37 Degrees Celsius for 10minutes after which the concentrations were measured directly with a spectrophotometer set to a wavelength of 500nm.

Figure 11: Cholesterol Enzymatic Reagent **(Original)**

2.3.2. Quantitative test for triglyceride:

- **Principle**

Triglycerides are measured enzymatically in serum using a series of coupled reactions in which they are hydrolyzed to produce glycerol. Glycerol is then oxidized using glycerol oxidase, and Hydrogen peroxide (H2O2).

- **Procedure**

Using the BIOMAGHREB test and maintaining the aforementioned protocol, 1000microlitres of the already prepared triglyceride reagent was measured into each of the 14 labelled tubes with the first tube as always, indicated for the blank reagent and the second for the standard. 10microlitres of the standard serum was added into the standard tube and 10microlitres each of serum from C and PJ groups were added individually to the 12 allocated tubes. The incubation time was 5minutes in water-bath set to a temperature of 37 Degrees Celsius and concentrations measured directly with a spectrophotometer of wavelength 578nm.

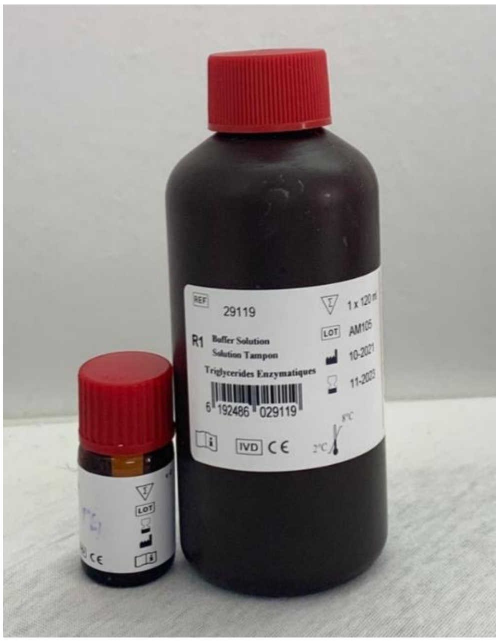


Figure 12: Triglyceride Enzymatic Reagent **(Original)**

2.3.3. Quantitative test for creatinine:

- **Principle**

Creatinine reacts with alkaline picrate forming a red complex known as creatinine-picric acid complex. The time interval chosen for measurements avoids interferences from other serum constituents. The intensity of the color formed is proportional to the creatinine concentration in the sample. This principle is based on Jaffe's reaction.

- **Procedure**

Using CEBIO testing kit and maintaining same positions of all 14 tubes, 800microlitres of first reagent (R1) which contains Disodium Phosphate and sodium hydroxide was added to all tubes after which 100microlitres of the standard serum, control group serum and experimental group serum were added to their respective allocated tubes. Next is an added 200microlitres of the second reagent (R2) containing sodium dodecyl sulphate and picric acid at a pH of 4.0. The concentrations of the contents of the tubes were then measured kinetically/instantly with a spectrophotometer set at a wavelength of 500nm and there was no incubation period in this procedure.

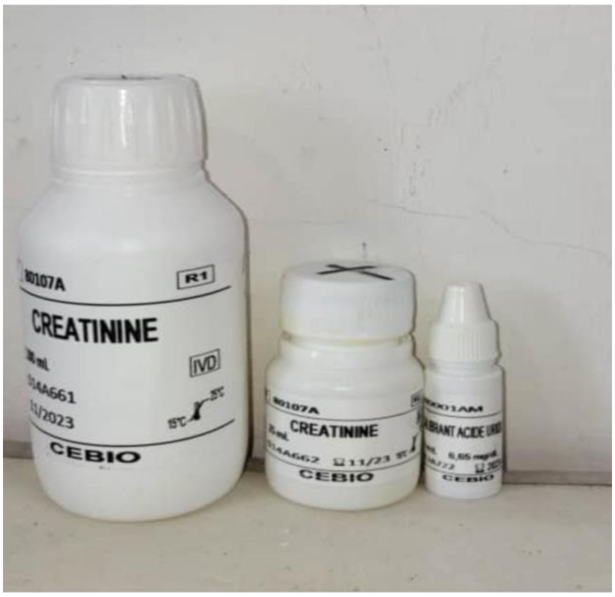


Figure 13: Creatine Reagent **(Original)**

2.3.4. Qualitative test for Glucose

- **Principle**

This principle is based on Tinder method, that is, Glucose is oxidized by GOD to gluconic acid and hydrogen peroxide which in conjunction with POD, reacts with chloro-4-phenol and PAP form a red quinonimine.

- **Procedure**

Using BIOLABO testing kit and maintaining same positions of all 14 test tubes, 1000microlitres of the already prepared glucose reagent was measured into each of the 14 labelled tubes with the first tube as always, indicated for the blank reagent and second tube for the standard. 10microlitres of the standard serum was added into the standard tube and 10microlitres each of serum from C and PJ groups were added individually to the 12 allocated tubes. The incubation time was 5minutes in water-bath set to a temperature of 37 Degrees Celsius and concentrations measured directly with a spectrophotometer of wavelength 500nm.

Figure 14: Glucose GOD-PAP reagent **(Original)**

2.4. Statistical Analyses

All results were tested for statistical significance using Student's t-test StatView software.

Results and Discussion

3. Results and Discussion

3.1. Effect of 10% pomegranate juice on serum total cholesterol

Pomegranate juice significantly reduced serum cholesterol as demonstrated in **(Fig. 15).** This result correlates with a study done by **(Al-Moraie *et al.*, 2013).** The hypocholesterolemic effect of pomegranate juice has been attributed to its various phytochemicals like polyphenols, flavonoids, vitamins and amino acids **(Newman *et al.*, 2007).** Studies by **McRae et al., 2008 and Traber et al., 2011** also indicates that vitamin C and E supplementation can influence serum cholesterol concentrations due to their antioxidant properties. They provide protection against oxidative stress-induced cellular damage by scavenging reactive oxygen species and by protecting proteins from alkylation through electrophilic lipid peroxidation. **Sahebkar *et al.*, 2016** have shown that pomegranate juice flavonoids are responsible for its strong antioxidative and anti-inflammatory potential just like its polyphenols. However, the specific mechanisms by which pomegranate flavonoids affect lipid metabolism are still being studied. In view of that, we speculate that lowered serum total cholesterol is due to arginine as studies by **Hadi et *al.*, 2019** indicates that pomegranate's arginine may reduce serum cholesterol through cholesterol or lipoprotein levels by decreasing the expression of hepatic 3-hydroxyl-3-methylglutaryl-CoA reductase mRNA, an enzyme involved in hepatic cholesterol biosynthesis. This action can deplete the intracellular cholesterol pool hence increase transportation of LDL-C to the liver which in turn decreases serum cholesterol. **(Stephen *et al.*, 2014).**

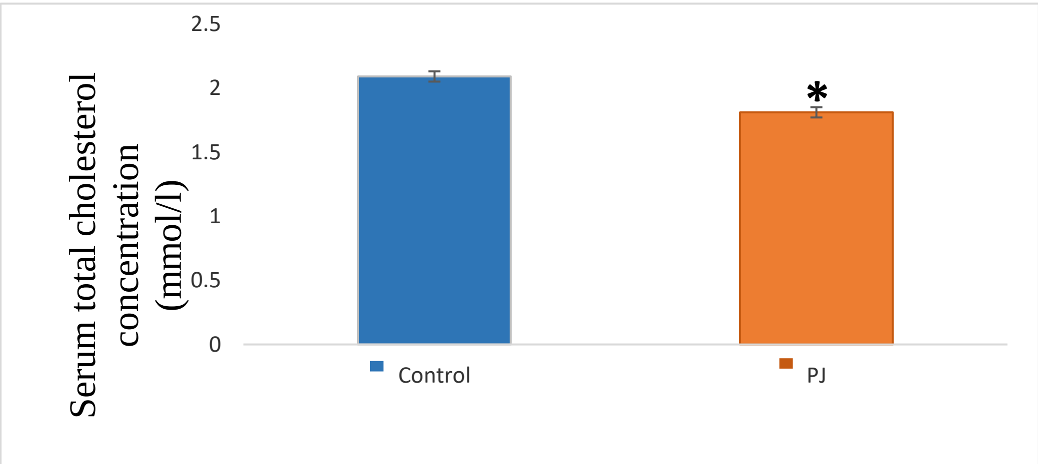


Figure 15: Effect of 10%pomegranate juice on serum total cholesterol
Values are means ±SE (n=6) for each group
"*" Significantly different from control by student's test (P<0.05)

3.2. Effect of 10% pomegranate juice on serum triglyceride

Our result in **(Fig. 16)** indicates that pomegranate juice consumption caused a drastic decrease in the triglyceride level of the experimental group (PJ) of rats compared to the control group (C) and these findings correspond with studies conducted by **(Rosenblat *et al.*, 2011)** which explains that the triglyceride-lowering effect of pomegranate juice is due to the protection of macrophages from triglyceride accumulation through the inhibition of DGAT1 activity, which is the rate-limiting enzyme in triglyceride biosynthesis. Studies by **(Les *et al.*, 2017; Rosenblat *et al.*, 2011)** demonstrates how two essential polyphenols (Punicalagin isomers and ellagic acid) in pomegranate juice actively decreases triglyceride levels through their antioxidative mechanisms and also how punicalagin has the ability to inhibit triglyceride biosynthesis. Meanwhile, we speculate that the arginine content of 10% pomegranate juice is adequately effective in decreasing serum triglyceride as studies by **(Khedara *et al.*, 1996)** demonstrates the hypotriglyceridemic effect of arginine which ameliorates the NO synthesis defects observed in some hyperlipidemic disorders. **Jobgen *et al.*, 2006** further explained how this NO increases the phosphorylation of hormone sensitive lipase and perilipins which lead to a translocation of the lipase to the neutral lipid droplets and, hence, stimulates lipolysis such as the degradation of triglycerides and its elimination hence reduces serum triglycerides. Several studies analyses have demonstrated that L-arginine can significantly decrease serum triglyceride. **(Hadi *et al.*, 2019).** However, further studies are required to measure the dose of arginine in pomegranate juice which is effective in exerting its anti-hypertriglyceridemic effect.

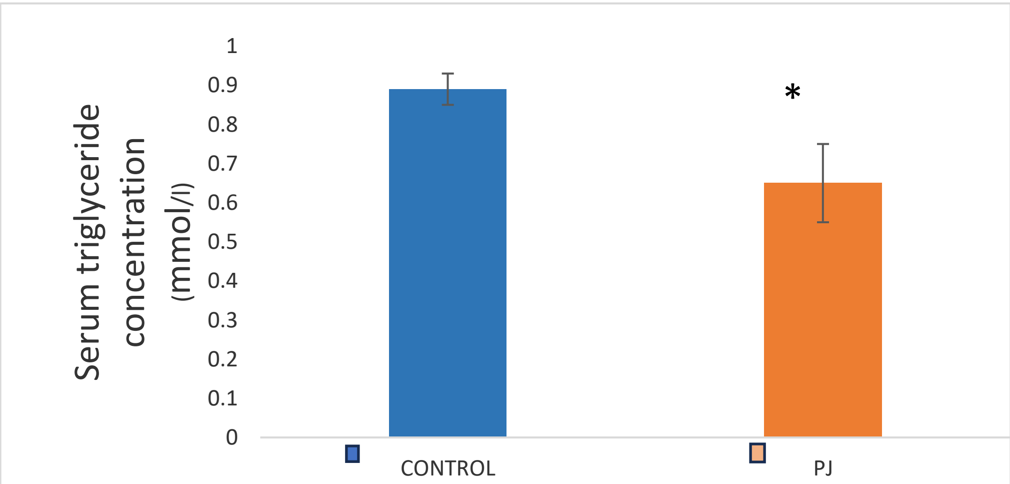


Figure 16: Effect of 10 % pomegranate juice on serum triglyceride
Values are means ±SE (n=6) for each group
"*" Significantly different from control by student's test (P<0.05)

3.3. Effect of 10% pomegranate juice on serum creatinine

No significant change was discovered after this test was conducted and this is to show that pomegranate juice did not influence creatinine level as results from both groups are similar and it explains that the hypolipidemic results of our experiment are not due to kidney-related disease but solely from the lipid-lowering effects of pomegranate juice phytochemicals such as polyphenols, vitamin C and E, and arginine as they have all been demonstrated to exert this effect**. (Les *et al.*, 2017; Mohiti *et al.*, 2010; Khedara *et al.*, 1996).**

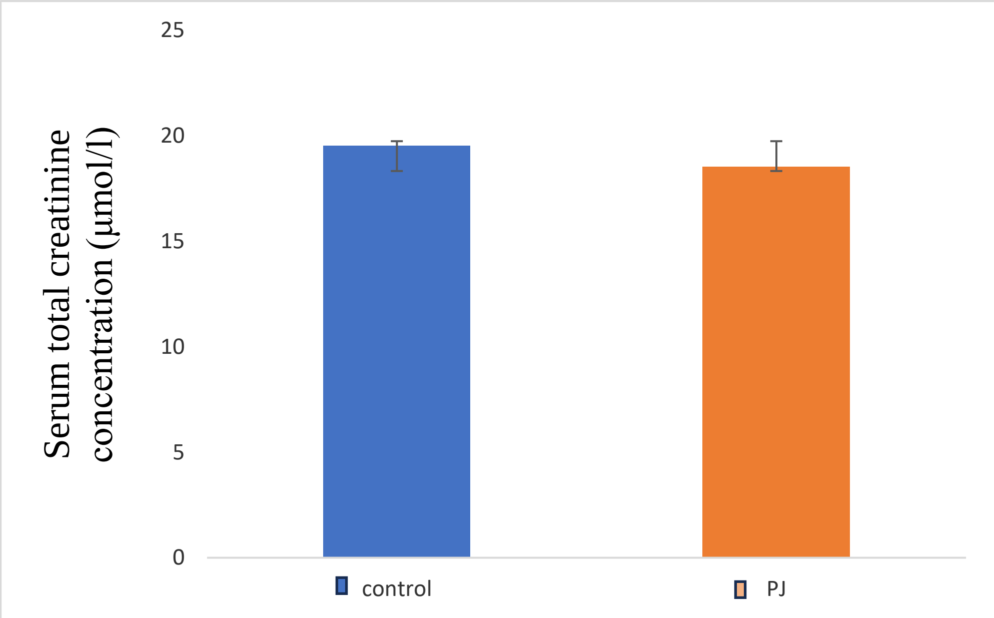


Figure 17: Effect of 10% pomegranate juice on serum creatinine
Values are means ±SE (n=6) for each group

3.4. Effect of 10% pomegranate juice on relative fatty liver, epididymal and perirenal adipose tissue.

The pomegranate juice supplementation effectively reduced epididymal and perirenal adipose tissues. However, no significant change occurred in the relative liver weights between both groups. Our results in **(fig. 18) and (fig. 19)** indicates for the first time that pomegranate juice can decrease white adipose tissue weight and we speculate this effect is due to the arginine content of the juice as it agrees with research by **(Tan B *et al.*, 2012)** which explained that dietary arginine supplementation effectively decreases white adipose tissue such as the epididymal and perirenal fats as it decreases the circulating levels of glucose and non-esterified fatty acids and increases oxidation of glucose and octanoate in white fat tissues. Meanwhile as decrease in liver weight is an indicator of a pathology, the liver weights of our control and experimental groups have no significant difference which shows that the hypolipidemic results obtained is in no way related to liver-related disease. Also, arginine is known for its effect in liver regeneration hence cannot provoke liver pathology which can eventually lead to a decreased liver weight. **(Kurokawa *et al.*, 2012)**

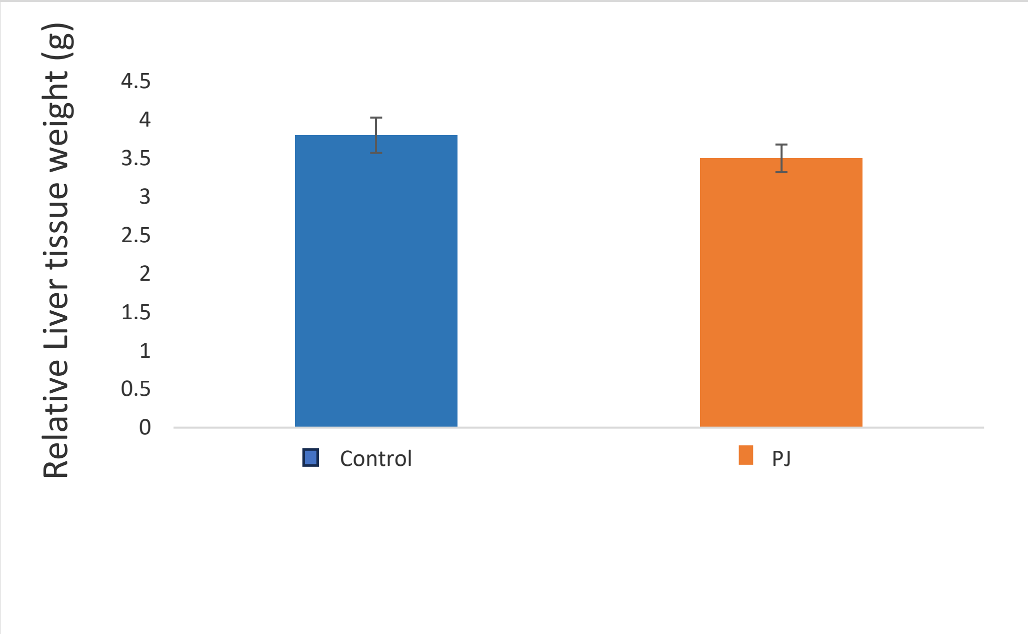


Figure 18: Effect 10 %of pomegranate juice on Relative Liver tissue weight
Values are means ±SE (n=6) for each group
"*" Significantly different from control by student's test (P<0.05)

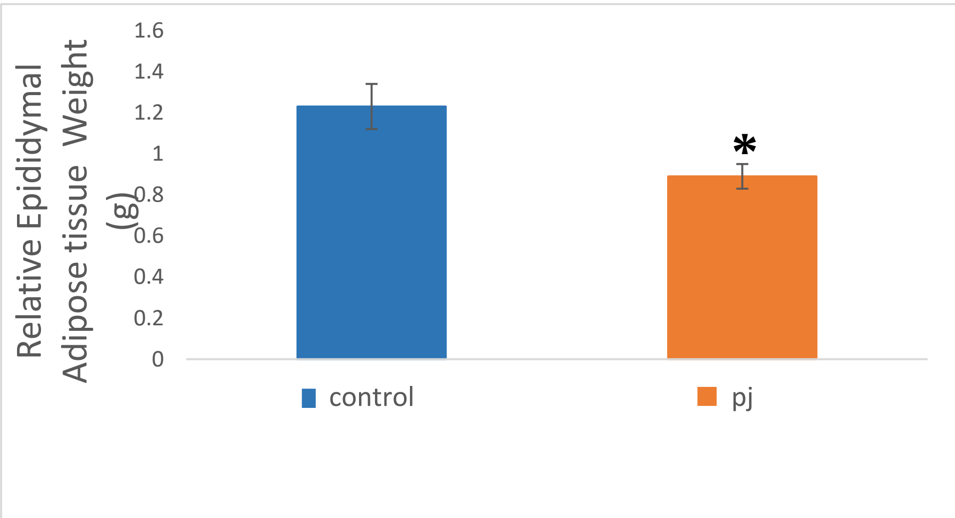


Figure 19: Effect of 10% pomegranate juice on Relative Epididymal Adipose tissue weight.
Values are means ±SE (n=6) for each group

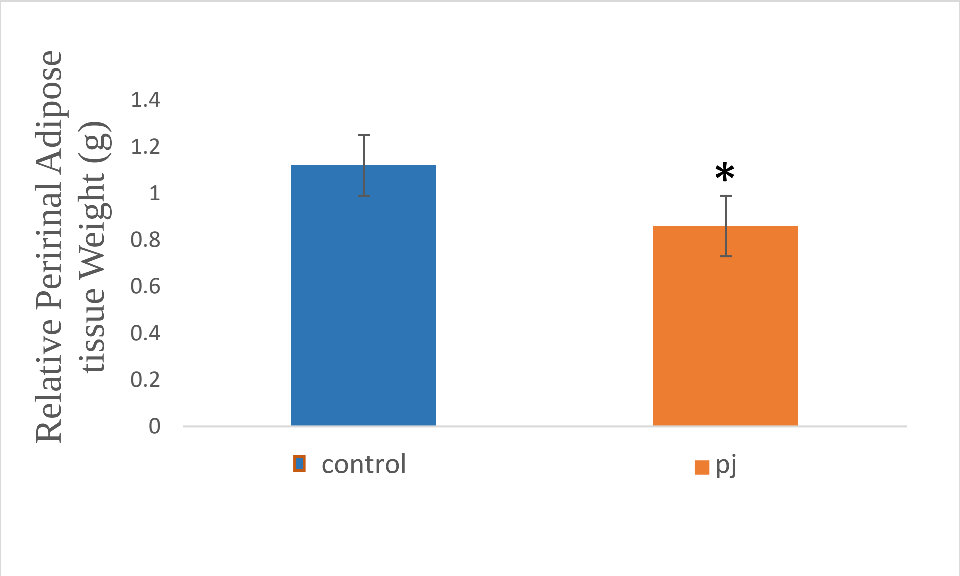


Figure 20: Effect of 10% pomegranate juice on Relative Perirenal Adipose tissue Weight

Values are means ±SE(n=6) for each group

"*" Significantly different from control by student's test (P<0.05)

3.5. Effect of 10% Pomegranate juice on Serum Glucose

Our result indicates a slight increase in the serum glucose level of the pomegranate-supplemented group compared to the control group. There have been irregularities about research results on effects of pomegranate juice on serum glucose which is due to varying factors. **(Olvera-Sandoval *et al.*, 2022).** Studies have shown that pomegranate juice may have a beneficial effect on glucose levels by decreasing glycemia **(Noori *et al.*, 2017)** but no evidence has been provided on whether it can increase serum glucose level as it is in our case and with this, we speculate it could be due to the presence of vitamin C in the juice as it has been shown through studies by **(Mohiti *et al.*, 2010)** to increase serum glucose through its antioxidant activity or due to different systematic responses and/or underlying health conditions. More studies are required to find out the mechanism in which pomegranate juice can increase glycemia in terms of dose and variety as some types of pomegranate fruits are high in glucose level than the others.

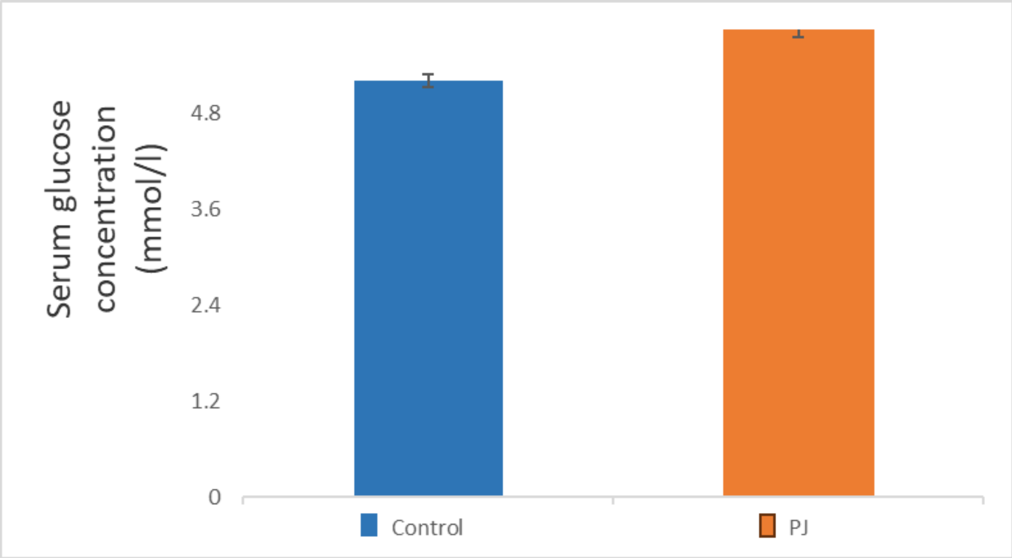


Figure 21: Effect of 10% pomegranate juice on serum glucose

Values are means ±SE(n=6) for each group

""* Means Significantly different from control by student's test (P<0.05)

3.6. Effect of 10% Pomegranate juice on final body weights

Considering that both groups of rats were obtained based on similar mean weights, we noticed about 3% decrease in final body weight of the experimental group in comparison with the control group, which is not significant. This indicates that the pomegranate juice resulted in a small amount of weight loss, which we speculate is related to the arginine content of the 10% pomegranate juice because it is highly promising in changing the balance of energy intake and expenditure, leading to increased calorie burning in favor of fat loss or decreased growth of white adipose tissue. **(McKnight *et al.*, 2010).** Weight loss is not not significant because rats were fed poor diets and this can have huge effect on calorie intake, its dispensation and use.

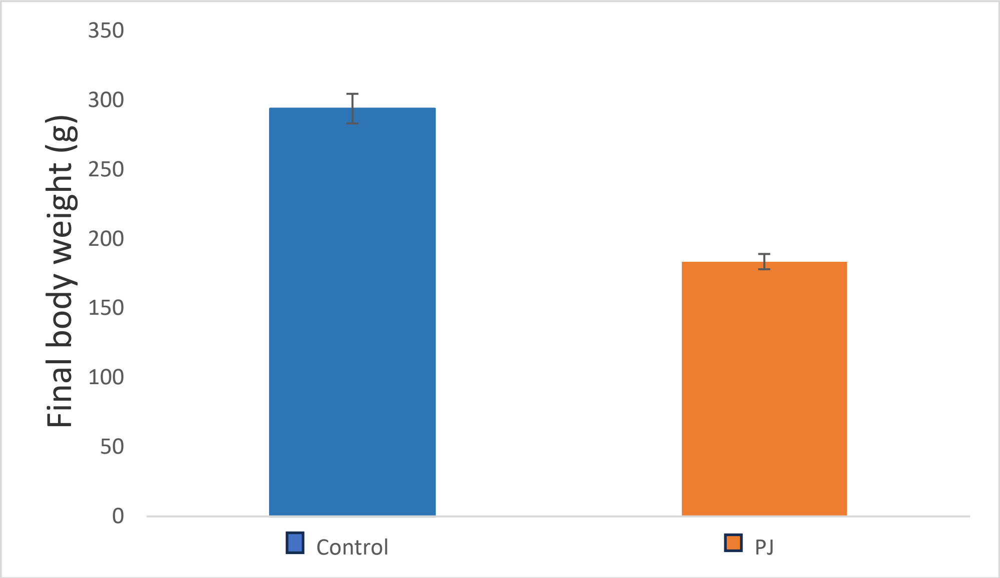


Figure 22: Effect of 10% pomegranate juice on Final Body Weight
Values are means ±SE(n=6) for each group

CONCLUSION AND FUTURE PERSPECTIVES

4. Conclusion and Future Perspectives

The consumption of pomegranate juice has a significant effect on lipid metabolism in rats. The results of our study showed a significant reduction in serum total cholesterol, triglycerides, and also decreased body weight, epididymal and perirenal adipose tissue weights with no significant change in relative liver weight. Also, there was no significant changes in creatinine and glucose levels as those tests were conducted to affirm the absence of kidney related disease and hyperglycemia as the presence of these disease/disorder can interrupt with the effect of pomegranate juice on lipid metabolism.

We attribute our result to the antioxidant and vasodilating properties of the juice's phytochemicals which appear to play crucial roles. This is explained by high levels of phytochemical compounds, such as polyphenols (punicalagin, ellagic acids, ellagitannins, anthocyanins), flavonoids, vitamin C and E with their antioxidant potential and amino acids specifically arginine, with its vasodilating property exerted through the NOS and sGC-dependent relaxation pathway. **(Newman *et al.*, 2007; Stuehr *et al.*, 2004; Khedara *et al.*, 1996; Mirmiran *et al.*, 2010).** Dietary arginine also decreases white adipose tissue weight through the decrease in circulation of serum glucose and non-esterified fatty acid, and increase in glucose and octanoate oxidation in the white adipose tissues. **(Tan et al., 2012).** With 10% juice used, we also suggest our result is dose-dependent as studies by **Esmaillzadeh *et al*., 2006** indicates that optimal doses of pomegranate juice have significant impact on lipid metabolism. The findings of this study support the earlier research that reported pomegranate juice has hypolipidemic effects and can ameliorate lipid metabolic disorder conditions. **(Mirmiran *et al.*, 2010; Al-Morraie *et al.*, 2013)**

In conclusion, pomegranate juice has a promising role in lipid metabolism, lipid-lowering effect and reduction in body weight and abdominal body fat with no implications on the liver and kidney. Also, our result is the first study to indicate that pomegranate juice has a decreasing effect on perirenal and epididymal adipose tissue weights. Even though studies were performed on rats, it needs extension into human research as these findings could be beneficial to people with dyslipidemia, obesity and cardiovascular diseases. Pomegranate juice may be a useful dietary supplement to reduce the incidence of heart diseases and overall body weight, but further studies are required to determine the optimal dosage and long-term effects and also, to deduce the detailed mechanism through which pomegranate juice's arginine decrease white adipose tissue weights.

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SUMMARY

The use of pomegranate juice has been known to have various health benefits, including the potential to reduce lipid profile, which may prevent the risk of cardiovascular diseases. We conducted a study on the effect of pomegranate juice on lipid metabolism in rats which was aimed at investigating how the consumption of 10% pomegranate juice decreases hypercholesterolemia, hypertriglyceridemia, and finally white adipose tissue weights (epididymal and perirenal tissue), and body weights without having implications on liver weight and kidneys.

The study was conducted on rats divided into two groups. For five weeks, the experimental group of rats was given 10% fresh pomegranate juice but the control group was given water. The results indicated that the experimental group had significant reduction in their serum total cholesterol and triglyceride level, a decreased final body weight, epididymal and perirenal tissue weight, and no significant change in the relative liver weight, but a slight increase in serum glucose which we speculate could be due to vitamin C or different systematic response and/or underlying health conditions as there is no literature evidence yet on hyperglycemic effect of pomegranate juice. The measured serum creatinine (indicator of renal function) showed no influence on this parameter, suggesting our results are not mediated through renal dysfunction process but solely by pomegranate juice's phytochemicals.

The study suggests that pomegranate juice is an effective way of controlling lipid metabolism in rats and should be further researched on its effects on humans. The mechanisms through which pomegranate juice acts to influence lipid metabolism in rats have been associated with the presence of polyphenols (punicalagin and ellagic acid), vitamin C and E, flavonoids which exert their effect through antioxidation and arginine which is the most of our interest also exerts its effect through the NOS pathway and sGC-dependent relaxation pathway of its end product (nitric oxide).

In conclusion, the study provides evidence that the consumption of 10% pomegranate juice decreased hypercholesterolemia and hypertriglyceridemia, final body weight and abdominal body fats whiles maintaining serum creatinine and liver weight normal with a slight increase in serum glucose. Pomegranate juice should be highly recommended for use in individuals with a predisposition to heart disease and other cardiovascular complications. Nonetheless, further studies are encouraged on pomegranate juice and how it affects human lipid metabolism.

Keywords: hypercholesterolemia, hypertriglyceridemia, hypolipidemia, phytochemicals

Résumé

L'utilisation du jus de grenade est connue pour avoir divers avantages pour la santé, notamment le potentiel de réduction du profil lipidique, ce qui peut prévenir le risque de maladies cardiovasculaires. Nous avons mené une étude sur l'effet du jus de grenade sur le métabolisme des lipides chez le rat qui visait à étudier comment la consommation de jus de grenade à 10 % diminue l'hypercholestérolémie, l'hypertriglycéridémie et enfin le poids du tissu adipeux blanc (tissu épididymaire et périrénal).

L'étude a été menée sur des rats divisés en deux groupes. Pendant cinq semaines, le groupe expérimental de rats a reçu 10 % de jus de grenade frais, mais le groupe témoin a reçu de l'eau. Les résultats ont indiqué que le groupe expérimental présentait une réduction significative de son taux sérique de cholestérol total et de triglycérides, une diminution du poids corporel final, du poids des tissus épididymaires et périrénaux, et aucun changement significatif du poids relatif du foie, mais une légère augmentation de la glycémie que nous spéculer pourrait être dû à vitamine C ou une réponse systématique différente et/ou à des conditions de santé sous-jacentes, car il n'existe pas encore de preuves dans la littérature sur l'effet hyperglycémique du jus de grenade. La créatinine sérique mesurée (indicateur de la fonction rénale) n'a montré aucune influence sur ce paramètre, ce qui suggère que nos résultats ne sont pas médiés par le processus de dysfonctionnement rénal mais uniquement par les composés phytochimiques du jus de grenade.

L'étude suggère que le jus de grenade est un moyen efficace de contrôler le métabolisme des lipides chez le rat et devrait faire l'objet de recherches supplémentaires sur ses effets sur l'homme. Les mécanismes par lesquels le jus de grenade agit pour influencer le métabolisme des lipides chez le rat ont été associés à la présence de polyphénols (punicalagine et acide ellagique), de vitamines C et E, de flavonoïdes qui exercent leur effet par antioxydation et d'arginine qui est le plus de notre intérêt également exerce son effet par la voie NOS et la voie de relaxation dépendante du sGC de son produit final (oxyde nitrique).

En conclusion, l'étude fournit des preuves que la consommation de jus de grenade à 10 % a diminué l'hypercholestérolémie et l'hypertriglycéridémie, le poids corporel final et les graisses corporelles abdominales tout en maintenant la créatinine sérique et le poids du foie normaux avec une légère augmentation de la glycémie. Le jus de grenade devrait être fortement recommandé pour une utilisation chez les personnes ayant une prédisposition aux maladies cardiaques et à d'autres complications cardiovasculaires. Néanmoins, d'autres études sont encouragées sur le jus de grenade et comment il affecte le métabolisme des lipides humains.

Mots clés : hypercholestérolémie, hypertriglycéridémie, hypolipidémie, composés phytochimiques

ملخص

من المعروف أن استخدام عصير الرمان له فوائد صحية مختلفة ، بما في ذلك القدرة على تقليل الدهون ، والتي يمكن أن تمنع خطر

الإصابة بأمراض القلب والأوعية الدموية. لقد أجرينا دراسة حول تأثير عصير الرمان على التمثيل الغذائي للدهون في الفئران والتي تهدف إلى التحقيق في كيفية استهلاك عصير الرمان بنسبة 10 ٪ يقلل من فرط كوليسترول الدم وزيادة شحوم الدم ,بالاضافة الى وزن الأنسجة الدهنية البيضاء (الأنسجة البربخية والحيوانية).

أجريت الدراسة على فئران مقسمة إلى مجموعتين. لمدة خمسة أسابيع ، تلقت المجموعة التجريبية من الفئران 10٪ عصير رمان طازج ، بينما تلقت المجموعة الضابطة الماء. أشارت النتائج إلى أن المجموعة التجريبية شهدت انخفاضًا معنويًا في مستويات الكوليسترول الكلي والدهون الثلاثية في الدم ، وانخفاض الوزن النهائي للجسم ، وأوزان الأنسجة البربخية والحيوية ، وعدم وجود تغيير معنوي في الوزن النسبي للكبد ، ولكن زيادة طفيفة في نسبة السكر في الدم والتي نتوقع أن يكون ذلك بسبب استجابة منهجية مختلفة و / أو ظروف صحية أساسية ، حيث لا يوجد دليل حتى الآن في الدراسات على تأثير ارتفاع السكر في الدم لعصير الرمان.

لم يُظهر الكرياتينين المُقاس في الدم (مؤشر وظائف الكلى) أي تأثير على هذه المعلمة ، مما يشير إلى أن نتائجنا لا يتم التوسط فيها من خلال عملية ضعف الكلى ولكن فقط من خلال المواد الكيميائية النباتية في عصير الرمان.

تشير الدراسة إلى أن عصير الرمان هو وسيلة فعالة للسيطرة على التمثيل الغذائي للدهون في الفئران ويجب التحقيق بشكل أكبر في آثاره على البشر. ارتبطت الآليات التي يعمل بها عصير الرمان للتأثير على التمثيل الغذائي للدهون في الفئران بوجود مادة البوليفينول (بانيكالاجين وحمض الإيلاجيك) وفيتامينات C و E والفلافونويد التي تمارس تأثيرها عن طريق مضادات الأكسدة والأرجينين التي تهمنا أيضًا. تأثيره من خلال مسار NOS ومسار الاسترخاء المعتمد على sGC لمنتجها النهائي (أكسيد النيتريك).

في الختام ، قدمت الدراسة دليلاً على أن استهلاك 10٪ من عصير الرمان قلل من فرط كوليسترول الدم وزيادة شحوم الدم ، ووزن الجسم النهائي ودهون البطن مع الحفاظ على مستوى الكرياتينين في الدم ووزن الكبد مع زيادة طفيفة في نسبة السكر في الدم. ينصح بشدة باستخدام عصير الرمان للأشخاص الذين لديهم استعداد للإصابة بأمراض القلب ومضاعفات القلب والأوعية الدموية الأخرى. ومع ذلك ، يتم تشجيع المزيد من الدراسات حول عصير الرمان وكيف يؤثر على التمثيل الغذائي للدهون البشرية.

الكلمات المفتاحية: فرط كوليسترول الدم ، فرط شحوم الدم ، نقص شحميات الدم ، المواد الكيميائية النباتية