



DEPARTMENT OF NUTRITION AND DIETETICS

**DETERMINATION OF OXALATE CONTENT OF SELECTED COMMERCIAL
CHOCOLATE CONFECTIONERY (CHOCOLATE ICE CREAMS AND COOKIES)**

By

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CERTIFICATION

This is to certify that this project work presented by ABDULKADIR NABABA RAHMAT with Matriculation Number ND/23/NAD/FT/0051 has been read, approved and submitted to the Department of Nutrition and Dietetics, Institute of Applied Sciences, Kwara State Polytechnic, Ilorin.

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DEDICATION

This is dedicated to my amiable mom, brother, sister and my man. Your endless love, sacrifices, and unwavering support have shaped me into who I am today.

Thank you for believing in me even when I doubted myself.

This achievement is as much yours as it is mine.

And also to my late class mate AFOLABI HABEEB may his soul rest in peace I wish we could see this journey through but death departed you from us.

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Abstract

The oxalate contents of a number of selected chocolate confectioneries (ice creams and cookies) were determined titrimetrically. The results showed that oxalate was present in all the samples and ranged between 2.328 mg/g and 64.30 mg/g. The Frosty bite ice cream (big size) had the highest oxalate content of 64.30 mg/g, followed by the Fab chocolate cookie with an oxalate content of 58.60 mg/g, the least oxalate content was found in the Festo chocolate cookie sample with 2.32 mg/g. Generally, the ice cream sample had slightly more oxalate content than the cookies. This study reveals that consumption of these chocolate confectioneries should be handled cautiously to reduce the risk of consuming much oxalate which may have its impact on health.

Keywords: *chocolate confectionery, ice cream, cookies, candies, oxalate.*

CHAPTER ONE

1.0 INTRODUCTION

Chocolate is considered the most popular sweet in every section of the age groups of people all over the world. The popularity of chocolate is not just an overnight sensation, it has taken several thousands years from Mayo people in 400 AD, who first planted the cacao tree to the Aztec people, who used cocoa beans as currency. Cocoa beans are the major ingredient of chocolate and related products. In 1875, Daniel Peter developed milk chocolate by using condensed milk powder from henri nestle. A major popular commercialization of chocolate occurred after the production of the first dark chocolate by Rudolph Lindt in Switzerland (1879) by involving the “conching” method; conching enhanced the smoothness of chocolate¹. The world’s annual cocoa production in 2021-22 was around 4.9 million tons. Around

1. Verma,R." The history and science of chocolate".The Malaysian journal of pathology.35,2(2013) 111-121
60% of the total cocoa beans are produced in the countries cote d’Ivoire and Ghana, followed by Ecuador with a 7% share (Swiss

platform for sustainable cocoa, 2022). Around 43% of the cocoa production are utilized by the chocolate industry. In 2021, revenue generated by the global chocolate confectionery market was US \$ 0.99 trillion². The Indian chocolate market was US \$ 2.4 billion and is expected to reach US \$ 4.1 billion in 2028 at a CAGR of 8.8% during 2023 -2028³. The growth of the cocoa sector is driven by its popularity, extensive appeal in all age groups, and perceived health benefits.

Earlier, the major concern regarding the consumption of chocolate was its high fat and sugar content leading to the development of caries, high blood pressure, coronary artery disease, and diabetes. However, now awareness about the functional and medicinal benefits of chocolate is gaining ground. Chocolate is a rich source of bioactive

2. Statista." Size of the chocolate confectionery market world wide from 2016 to 2017". A review (2022)

3. Indian chocolate market." Industry trends, share,size, growth, opportunity and forecast ". India chocolate market (2022)

compounds that have beneficial effects on heart health, insulin secretion, and brain function among others⁴. Research studies are

reporting the effect of the use of chocolate on multiple ailments and conditions including aging, high blood pressure, gut microbiota, cancer, depression, diabetes, and Alzheimer's disease among others.

This paper reviews the bioactive compounds in chocolate, the role of chocolate as a functional food, and recent developments in improving the functional properties of the chocolates. It highlights the efficiency of chocolate in the systemic health, metabolism, and immune system beyond its consideration as good mood food.

1.1 PROBLEM STATEMENT

Chocolate confectionaries (ice cream, cookies and candies) are frequently consumed among both young children and adults.

Regular consumption of confectionaries such as ice cream, cookies and candies poses significant health risks, including obesity, dental issues, increased risk of kidney stones formation and other diet related issues, thereby compromising overall health and wellbeing.

1.2. AIM AND OBJECTIVE OF DETERMINING THE OXALATE CONTENT OF SELECTED COMMERCIAL CHOCOLATE CONFECTIONERY (CANDIES)

The primary aim of this study is to determine and quantify the oxalate content of the selected commercial chocolate confectionery products (chocolate candies)

Specific objectives

- i. To sample chocolate candies sold within Ilorin metropolis by buying from retailers and shopping malls.
- ii. To digest the samples with sulfuric acid so as to release the oxalate
- iii. To quantify the oxalate in each sample by titrimetric method
- iv. To compare the oxalate content of the different types of chocolate products (candies and chocolate).

1.3. JUSTIFICATION OF THE STUDY

Public Health Concerns: Oxalates are a key component in the formation of kidney stones, and excessive consumption of oxalate-rich foods can increase the risk of kidney stone formation. This study will provide valuable information on the oxalate content of commercial chocolate candies, enabling consumers to make informed choices about their diet.

Knowledge Gap: Despite the potential health implications, there is a lack of accurate and reliable data on the oxalate content of commercial chocolate candies. This study will address this knowledge gap, providing new insights and data on the oxalate content of these products.

Regulatory Compliance: Food safety regulations and guidelines require manufacturers to provide accurate labeling information about the oxalate content of their products. This study will support

regulatory compliance by providing manufacturers with accurate data on the oxalate content of their products.

Consumer Awareness: This study will provide consumers with accurate information about the oxalate content of commercial chocolate candies, enabling them to make informed choices about their diet and lifestyle.

Contribution to Existing Literature: This study will contribute to the existing body of research on oxalate content in food products, providing new insights and data for future studies.

1.4 SCOPE OF DETERMINING OXALATE CONTENT OF CHOCOLATE CANDIES

The study will focus on obtaining selected commercial chocolate candies, and quantification of the oxalate in each sample.

1.5 RELEVANCE OF THE STUDY

Public Health Significance: The study's findings on the oxalate content of chocolate candies will inform consumers, particularly those with kidney stone issues or other oxalate-related health concerns.

Food Safety and Regulation: The study's results will contribute to ensuring compliance with food safety regulations and guidelines related to oxalate content in food products.

Consumer Awareness and Education: The study will provide valuable information to consumers, enabling them to make informed choices about their diet and lifestyle.

Product Development and Reformulation: The study's findings will inform manufacturers about the oxalate content of their products, guiding them in developing new products or reformulating existing ones to reduce oxalate content.

Contribution to Existing Literature: The study will contribute to the existing body of research on oxalate content in food products, providing new insights and data for future studies.

CHAPTER TWO

2.0 LITERATURE REVIEW

This literature review examines the health implications of dietary oxalate consumption, focusing on its role in kidney stone formation and associated health risks. Oxalates, naturally occurring compounds in many foods, particularly vegetables, have been linked to increased calcium oxalate stone formation, with studies indicating a direct correlation between high dietary oxalate intake and the prevalence of kidney stones. The review highlights key dietary factors contributing to stone development, including calcium intake, the influence of gut microbiota, and the impact of various food types, such as high oxalate vegetables and sugary beverages. It also discusses socioeconomic disparities in kidney stone prevalence and emphasizes the importance of personalized dietary interventions, including limiting oxalate rich foods and incorporating adequate calcium intake to mitigate urinary oxalate excretion.

2.1. BIOLOGY OF COCOA

Cocoa is a dried and fully fermented cocoa bean product from *Theobroma cacao*, an evergreen tree in the family malvaceae. The name signifies "Food of God" in Greek. There are two main groups of cocoa beans, purple seeded forastero, the most widely used cocoa bean, and criollo, the lesser used mild flavoured high-quality cocoa⁵. The cocoa plant is a branching tree with simple, pointed (lanceolate) leaves measuring up to 61cm (24 in) long and 10 cm (4 in) wide. The tree produces clusters of pale- yellow flowers each with five petals and sepals. The cocoa pods can be green-white, yellow, purplish or red in color each of which contains 20-50 seeds, the cocoa beans are arranged in five distinct rows. The plant has its origin in the upper Amazon region of south America⁶.

4. Taubert,D; Roesen,R.,&schomig E." Effects of cocoa and tea intake on blood pressure;a meta analysis". *Archive of internal medicine* 167,7(2007) 626-634
5. Sein,M.M.,kyi.Cm; & phyu,s.l.l" studies on preparation and physio-chemical properties of chocolate from indigenous cocoa beans ".*West Yangon university research journal*.1(2009)1-5
6. Plant village (2022). *Cocoa*,retrieved in 2023, June 15

2.2. COMPONENTS OF COCOA

Cocoa beans have a composition that includes lipids, carbohydrates, proteins, minerals and bioactive components with rich functional properties. The main component of cocoa beans is lipid fraction, the cocoa butter approximately 50%, mainly constituted by neural lipids, with a predominant fraction of triglyceride molecules. Oleic acid, stearic acid and palmitic acid are the main constituents of cocoa butter. Protein fraction constitutes 10% to 15% of the dry weight of cocoa seeds, and it is composed of 52% and 43% of albumin and globulin fractions, respectively. Other proteins, such as glutelins and prolamins, are present in lower concentrations. Cocoa beans are also rich in carbohydrates 31%, fiber 16%, and minerals⁷. Cocoa beans contain stimulant substances, such as theobromine, caffeine, and theophylline, named purinic alkaloids, which affect the central nervous system⁸.

7. Shahanas E., panjikkaran,s.T.,et al" Health benefits of bioactive compounds from cocoa". Agricultural research.40,2(2019)143-149
8. Bertazzo A.,comais .,mangiarini,F et al" composition of cocoa beans". Chocolate in health nutrition.A review 7,10(2013) 105-117

2.3. PROCESSING OF CHOCOLATE

Cocoa fruit at the harvesting stage contains about 30-40 seeds. The seeds are covered by a mucilaginous pulp which is removed by yeast and bacteria during fermentation. The fermentation step is essential for the development of chocolate flavor and lasts from three to seven days. This step also produces aroma precursors. Fermentation is followed by drying where the moisture content is reduced to 5% to 7% at 45°C to 60°C and shelf life is increased. Dried cocoa beans or nibs are then broken to reduce the size of the kernel and then roasted at around 120°C to 150°C to develop the chocolate flavor. The nibs are then ground to cocoa liquor.

The dark chocolate is made by mixing cocoa liquor, sugar, Cocoa butter and emulsifiers. To produce milk chocolate, milk, and other ingredients are added and refined to reduce the particle size of solids.

After refining the moisture undergoes a conching operation wherein the chocolate mass is agitated at a high temperature of around 50°C .

Conching is followed by tempering, which consists of heating, cooling, and mixing^{9,10}.

2.4 TYPES OF CHOCOLATE

There are several types of chocolate with types including dark chocolate, white chocolate and milk chocolate. Among these types of chocolate, dark chocolate has gained some form of prominence because of its health benefits. Dark chocolate became part of the delicacies of the south Americans about 3000 years ago as history will have it and it was later shipped to Europe by Christopher Columbus¹¹. The composition of white and milk chocolate includes cocoa butter, milk, and sugar and low amounts of cocoa bean solid (<10% of total weight) respectively¹². Notably, the westerner views dark chocolate as one with a higher content of cocoa and vice versa for milk chocolate also referred to as sweet chocolate.

9. Dimattia,C.D; sacchwti,G;Mastrocola,D,et al. "The impact of processing on invitro antioxidants activity and the effects of chocolate on antioxidant markers in vivo" journal of frontiers in immunology 8,1207(2017)

10. Shafi,F.,Reshi M.,Aiman & Bashir" chocolate processing". International journal of advanced Biological research

11. Dillinger TL,Barriga P,Escarcegas et al " Food of the gods: cure for human?". Journal of nutrition.130,8 2057-2072

12. Corti R,perdix j ,flammer AJ,et al " Dark or white chocolate? Cocoa and cardiovascular health ".Rev med suisse.2010;6(239):499-500

2.5 BENEFITS OF CHOCOLATE CONSUMPTION

Despite the harmful effects high consumption of chocolate causes, moderate consumption of the same has proven to provide health benefits¹³.

One of the health benefits of consumption of chocolate focused on is cardiovascular health¹⁴. Through several pathways, consumers of chocolate may be protected from cardiovascular diseases because of the flavonoids component. Flavonoids may also have other influences by acting as antioxidant, anti-platelet and anti-inflammatory agent¹⁵. Other latent risk factors of cardiovascular diseases such as hypercholesterolemia, hypertension may be improved by flavonoids as well as improvement on endothelial functions¹⁶. Apart from the cardiovascular health benefits consumption of chocolate may have, it also may have neurological health benefits and benign other ailments¹⁶.

13. Latif R. Chocolate/Cocoa and human health: a review. *Neth J Med*. 2013;71(2):63-68.

14. Larsson SC. "Coffee, tea and cocoa and cardiovascular health". *Circulation*. 45,1(2014)309-314

15. R. Corti, A. J. Flammer, N. K Hollenberg. "Cocoa and cardiovascular health". *Circulation*. 2009, 119,10, 1433-1441

16. L. D. Latham, D. S. Hensenzk, Minor. "Chocolate guilty pleasure or healthy supplement?". *Jclin hypertens*. 2010, 16, 2, 1608-1609

2.6 FUNCTIONAL PROPERTIES OF CHOCOLATE

The different functional properties of chocolate are as follows:

2.6.1 Chocolate as an antioxidant

The utilization of natural antioxidants was obligated as a rational strategy to combat stress - related diseases. Plant polyphenols are considered to be important dietary antioxidants, and dietary intake of these compounds can be up to 1200mg per day. Flavonoids, phenolic acids, and procyanidins are considered the main polyphenol classes and they all possess strong antioxidant potential confirmed in chemical based assays¹⁷. Single servings of cocoa and cocoa products are found to contain more phenolic antioxidants than most other foods.

2.6.2 Chocolate as cardio-protective

Sakaki et al (2019)¹⁸ highlighted the polyphenols protection role against cardiovascular heart disease by acting as antioxidants and

17. Srdic- Rajic,T.,& Ristic,A.k."Antioxidants:Role on health and prevention ". Encyclopedia of food and health (2016)227-233

18. Sakaki J,Melough.M; Lee,s.G,et al" polyphenol- rich diets in cardiovascular diseases prevention". Analysis in nutrition research.(2019)259-298.

impairing the development of atherosclerosis. Polyphenol- rich diets have been shown in several clinical trials to be useful in the prevention and treatment of CVDs due to their antioxidants, anti-inflammatory, anti-platelet, and other pleiotropic effect¹⁹.

2.6.3. Chocolate for Alzheimer's disease (AD)

Alzheimer's disease is a neurodegenerative disorder in which gradual cognitive impairment leading to dementia is observed. clinical and epidemiological findings suggest a protective effect of flavonoids and polyphenols against neurodegenerative disease are supported by data obtained in animal model²⁰.

2.6.4. Chocolate as a good mood food

Positive mood can be created in various ways but if food can make mood positive then it is just like icing on the cake. Chocolate is

- 19.Behl,T.,Bungau,s. Kumar,k.,et al " pleotropic effects of polyphenols in cardiovascular system". Journal of Biomedicine and pharmacotherapy (2020)
20. Calderaro,A; patane G.T., Tellone E., et al " The neuroprotective potentially of flavonoids on Alzheimer's disease". International journal of molecular sciences 23,23(2022)

considered a good mood food due to the presence of numerous compounds, that act on the brain and produce a sense of delight that no other food matches²¹.

2.6.5. Chocolate as antidiabetic

Antioxidant effects of cocoa polyphenols directly influence insulin resistance and, in turn, minimize the risk for diabetes. Insuline sensitivity can also be improved by the vasodilatory effects of cocoa²². Precise intake of dark chocolate enhances insulin sensitivity in healthy as well as glucose intolerant hypertensive people²³.

21. Shin J.H., ki,c.s.,Cha,L.,et al " consumption of 85% dark chocolate improves mood in association with gut microbia changes in healthy adults". The journal of nutritionional Biochemistry.(2022).
22. Shah,s.,Alweis,R,Najim N.,et al" use of dark chocolate for diabetic patients".A review of the literature and current evidence, Journal of community Hospital internal medicine perspectives.7,4(2017) 218-221
- 23.Ackar,D.Valek Lendic ,K.,valek,M.,et al "Cocoa polyphenols: can we consider cocoa and chocolate as potential functional food?". Journal of chemistry (2013).

2.7. EFFECT OF PROCESSING ON FUNCTIONAL PROPERTIES OF CHOCOLATE

During the drying of cocoa beans, the brown polymers are synthesized as a result of oxidation of polyphenols, thus helping to form new flavor compound and reduce bitterness²⁴. High temperature processing may lead to the loss of some important features of beans like texture, color ,and also some bioactive compounds such as polyphenols. So, it is important to cautiously select the relevant roasting process.

2.8. HEALTH IMPLICATIONS OF OXALATE CONSUMPTION

Oxalate, which are naturally occurring organic compounds present in many foods, have attracted considerable interest because of their potential health effects.

High dietary oxalate intake has been associated with an increased risk of kidney stone formation, particularly calcium oxalate stones.

24. Goya,L., Lippi,c., Necozone,s; et al " Effect of processing on flavonoids and methylxanthines and their mechanism of action ". International journal of molecular sciences,23,22(2022)

Kidney stone formation related to diet is influenced primarily by three factors: the consumption of oxalate, the intake of calcium and other divalent cations, and the intestinal handling of oxalate.

However, according to there are ten foods forbidden for people prone to kidney diseases. They are spinach, rhubarb, beets, nuts, chocolate, concentrated brans, legumes, regular tea, parsley and berries. A better understanding of the mechanisms and risk factors involved in kidney stone formation could help in creating innovative prevention strategies.

2.9 HYPEROXALURIA

Oxalate is the final product of glyoxylate oxidation, an intermediate of glycine metabolism and is abundantly present in vegetables. In normal conditions the amount of oxalate from endogenous metabolism and from the diet is low and daily oxaluria ranges from 15 to 30 mg. Approximately 50% comes from the diet. Its solubility depends on urinary pH and the presence of calcium ions and it is generally completely dissociated in the urine. Increased excretion

of urinary calcium can cause calcium-oxalate crystals formation. The intestinal absorption of oxalate depends on the availability of free calcium in the intestinal lumen. If this is reduced (low calcium diet, malabsorption, etc.) oxalate can be easily absorbed²⁵. On the other hand, reducing oxalate in the diet increases intestinal calcium absorption. Therefore, controlling oxalate-rich foods (Table 4.2 below)²⁶ intake may be advisable in case of hyperoxaluria, but limiting fruit and vegetables consumption is not wise. The reason is not simply because of the general positive effects of a healthy diet, but also for the specific effect on the urine stone risk that a dietary restriction of fruit and vegetables would have. In fact, it can induce a moderate increase of calcium absorption and excretion, and cause a

25. Taylor, E.N. Dietary Factors and the Risk of Incident Kidney Stones in Men: New Insights after 14 Years of Follow-up. *J. Am. Soc. Nephrol.* 2004, 15, 3225–3232.
26. Han, H.; Segal, A.M.; Seifter, J.L.; Dwyer, J.T. Nutritional Management of Kidney Stones (Nephrolithiasis). *Clin. Nutr. Res.* 2015, 4, 137–152.

decrease of crystallization protective molecules such as magnesium, citrate, potassium²⁷. Meanwhile, the addition of fruit and vegetables in stone formers with low levels of urinary citrate did not change oxalate excretion while it did reduce the lithogenic risk because of the increase in urinary magnesium, citrate, potassium, pH and volume²⁸.

27. Nouvenne, A.; Ticinesi, A.; Morelli, I.; Guida, L.; Borghi, L.; Meschi, T. Fad diets and their effect on urinary stone formation. *Transl. Androl. Urol.* 2014, 3, 303–312.
28. Meschi, T.; Maggiore, U.; Fiaccadori, E.; Schianchi, T.; Bosi, S.; Adorni, G.; Ridolo, E.; Guerra, A.; Allegri, F.; Novarini, A.; et al. The effect of fruits and vegetables on urinary stone risk factors. *Kidney Int.* 2004, 66, 2402–2410.

CHAPTER THREE

3.0 EXPERIMENTAL

3.1 REAGENT & APPARATUS

3.1.1 Reagents

Potassium permanganate (KMnO_4), sulfuric acid (H_2SO_4), oxalic acid, and distilled water.

3.1.2 Apparatus and equipment

Volumetric flask, Erlenmeyer flask, Electronic balance, Standard weight, Filter paper, Funnel, Measuring cylinder, retort stand and clamp, burette, pipet.

3.1.3 Samples used

- i. Fab biscuit (cookie)
- ii. Festo biscuit (cookie)
- iii. Mcvities dark chocolate (cookie)

iv. Frosty bite big size (ice cream)

v. Frosty bite small size (ice cream)

vi. Go slo (ice cream)

3.2 COLLECTION OF SAMPLES

The chocolate cookies and ice cream samples were purchased from retail sellers and shopping malls with Ilorin metropolis.

Each sample was ensured to be sealed at the time of purchase and were kept at freezing temperatures till the time of analysis.

3.3 PREPARATION OF SAMPLES

The ice cream was each weighed while frozen once the pack was unsealed without any other treatment. Each sample of the cookies was pulverized with a clean dry ceramic mortar and pestle.

3.4. PREPARATION OF SOLUTION

3.4.1. 0.5M sulphuric acid solution

54.35ml of concentrated sulphuric acid (stock solution) was carefully measured into a small quantity of water in a 2L standard (volumetric) flask. The content of the flask was mixed by swirling the flask without splashing the content. More distilled water was added to make up to the mark. The standard flask was stoppered and inverted severally to mix properly. This gives approximately 0.5M H_2SO_4 solution.

3.4.2. Preparation of 0.025M Potassium permanganate solution (KMnO_4)

7.90g of potassium permanganate crystals, and dissolved in a small amount of distilled. The solution was quantitatively transferred into a 2L volumetric flask and topped off with more distilled water . The solution was transferred into an amber bottle (2.5L) and tightly stoppered . This KMnO_4 solution was used for the redox titration to determine the oxalate

3.4.3 Preparation of 0.1M oxalic acid solution ($\text{C}_2\text{O}_4\text{H}_2$)

9.03g of oxalic acid crystals were accurately weighed into a clean dry beaker, small quantity of distilled water was added to dissolve the crystals. The solution was quantitatively transferred into a clean 1L standard flask and made up to the mark with more distilled water. The content of the flask was inverted severally to properly mix the solution. The oxalic acid solution was used in standardizing the KMnO_4 solution.

3.5. DIGESTION OF SAMPLES

5g of each pulverized sample was carefully weighed and 50ml of 0.5M sulphuric acid solution added, swirled and boiled for 15 minutes to free the oxalate in the sample. The solution was filtered and 10ml of each filtrate was diluted to 100ml with distilled water. This was used for the titrimetric analysis.

3.6. STANDARDIZATION OF KMnO₄ SOLUTION

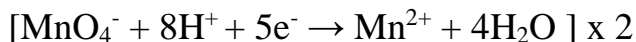
10ml of the 0.1m oxalic acid solution was pipetted into a clean 250ml Erlenmeyer flask. 15ml of 0.5M H₂SO₄ was added to 60±5°C.

The content was titrated hot against KMnO₄ solution from a burette to a faint pink end point. The titration was repeated to obtain 2 or 3 concordant titres. By mole concept the exact concentration of the KMnO₄ solution was obtained using the chemical reaction and the molecular chemical equation is given below.

Reduction half reaction:



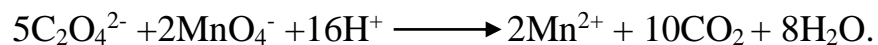
Ionic equation:



Oxidation half reaction



The complete equation is given as follows;



3.7 DETERMINATION OF OXALATE CONTENT

10ml of each of the diluted solution of each samples was pipetted into a clean Erlenmeyer flask. 15ml of 0.5M H_2SO_4 was added and the content heated to $60 \pm 5^\circ\text{C}$. The hot solution was immediately titrated hot against the standardized KMnO_4 solution. The titration was repeated to obtain at least two (2) concordant titres from each samples.

The oxalate content was calculated by employing the same equation of reaction used during standardization.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

The results of the oxalate content of the various chocolate candies analyzed are shown on the table 4.1 below.

Table 4.1: Results of oxalate contents of different chocolate ice creams and cookies

PRODUCT	OXALATE CONTENT (mg/g)
Frosty bite ice cream (small size)	19.36
Festo biscuit (cookie)	2.32
Go-slo ice cream	3.27
Frosty bite ice cream (big size)	64.30
Fab chocolate biscuit (cookie)	58.60
Mcvites dark chocolate (cookie)	7.75

4.2 DISCUSSION

Foods have been typically grouped into four (4) categories based on their oxalate contents²⁹ as shown in the table below.

Table 4.2: Foods grouped in 4 categories by oxalate content

Very High >100 mg per Serving	High 26–99 mg per Serving	Moderate 10–25 mg per Serving	Low 5–9 mg per Serving
Whole grain products	Hazelnuts	Beans	Artichokes
Almond	Cashew	Blueberries	Asparagus (cooked)
Cocoa powder	Peanuts	Potatoes	Lettuce
Buckwheat	Milk chocolate	Tomato sauce	Peas
Beet	Carrots	Blackberries	Apples
Rhubarb	Cauliflower	Walnuts	Pear
Spinach	Celery	Prunes (dried)	Melon
Swiss chard	Orange		

The results from this study showed that all the samples of ice creams and cookies analyzed contained oxalate. The values ranged between 2.32mg/g o 64.30 mg/g. The Frosty bite ice cream (big size) had the highest oxalate content of 64.30 mg/g, followed by the Fab chocolate cookie with an oxalate

29. Claudia D'Alessandro, et al. "Which Diet for Calcium Stone Patients: A Real-World Approach to Preventive Care". *Nutrients* 2019, 11, 1182, 1-16.

content of 58.60 mg/g, the least oxalate content was found in the Festo chocolate cookie sample with 2.32 mg/g. Generally, the ice cream sample had slightly more oxalate content than the cookies. Several factors may be attributed to varying oxalate contents in these samples such as differences in the production processes by the individual manufacturer, differences in the oxalate content of the raw material i.e. cocoa used in producing the chocolate and the differences in the quantity of chocolate used in producing each product.

All the samples of chocolate confectioneries employed in this study will belong to any of the four (4) categories of food based on oxalate content as presented in Table 4.2 above depending on the quantity of each used per serving.

This study therefore reveals that consumption of these chocolate ice creams and cookies should be handled cautiously to reduce the risk of consuming much oxalate which may have its impact on health.

Manufacturers of these products should be made to include the oxalate content on the food labels to better inform the consumers and to help them

monitor their consumption of oxalate-containing foods, beverages and confectioneries.

4.3 CONCLUSION

Chocolate confectionery is one of the most consumed class of confectioneries. Many people are uninformed of its oxalate content and the role it plays in the kidney stone disease. It is now important as dieticians to enlighten people to be cautious of their consumption of these chocolate ice creams and cookies for prevention and management of the attendant health outcomes.

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