ASSAY OF PHYSICOCHEMICAL AND ANTIOXIDANT PROPERTIES OF SELECTED LIQUID HERBAL PRODUCTS

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CERTIFICATION

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DEDICATION

This project is dedicated to God Almighty whose loving kindness is abundant in my life, grateful for how God see me through pharmacy school and also to my late mum, Late Mrs. Igara Susan.

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ABSTRACT

Background: Herbal products, typically derived from plant sources, are often perceived as safer alternatives and are widely used for their therapeutic and antioxidant benefits. This study will help to determine physicochemical and antioxidant properties of some selected liquid herbal products.

Methods: Seven selected liquid herbal products (Mojeaga herbal remedy, Goodwill's herbal mixture, pro-life herbal remedy malaria & Typhoid, Goko cleanser, Ganacin G-7 ulcer solution, Evaking herbs ulcer & pile removal and orijin bitter) were obtained from various pharmacies throughout Edo State, Nigeria. Samples underwent sensory evaluation, followed by measurements of specific gravity, pH, viscosity, and antioxidant properties through DPPH radical scavenging activity using spectrophotometric analysis at 517 nm wavelength.

Results: The organoleptic properties evaluation of the products revealed that most of the samples had a very strong characteristics odor, except Mojeaga and Goodswill that have aromatic scent, they all taste bitter except Ganacin and Evakings herbs that were sweet and tasteless. In terms of color, majority of the products showed deep brown coloration, while Ganacin and goko cleanser appeared moudy and dark. The specific gravity ranges from (0.72 to 1.83 g/mL). The pH analysis showed that all products were acidic (ranging from 3.10 to 6.96).

All seven herbal products exhibited high viscosity which ranges from (2805 to 5748 cp). The antioxidant assay indicated that all the products contain antioxidant which ranges from (39.13% to 65.22%).

Conclusion: The findings suggest that most of the evaluated herbal products possess notable antioxidant properties and favorable physicochemical characteristics. These attributes act synergistically to enhance product stability and reduce the risk of degradation or contamination during storage. Moreover, the antioxidant potential of these formulations may contribute to protection against infections and minimize adverse effects when used by patients.

CHAPTER ONE

1.1. Introduction

The World Health Organization defines herbal medicines as labeled therapeutic formulations where the active components originate from various plant parts including aerial or subterranean parts and are utilized in their natural state or as processed preparations. These formulations may include juices, gums, fatty oils, essentials oils, and any other substances of this nature. (WHO, 2023).

Across the globe, medicines sourced from natural materials, including herbal preparations, remain integral to healthcare practices. The safety profile of these plant-based treatments is generally perceived to match that of synthetically manufactured drugs. Medicinal plants form the backbone of traditional healing practices and are commonly used as household remedies.. The past decades have seen a significant increase in the use of herbal medicine due to their minimal side effects, availability and acceptability to the majority of the populace of third world countries (Pohl *et al.,* 2018; Najla *et al.,* 2022).

Herbs contain different pharmacological and therapeutically bio-active substances of varying structures and properties, including, alkaloids, fibers, organic acids, phenol compounds, phytates, pigments, polysaccharides, saponins, tannins, vitamins, as well as matels (Pohl *et al.,* 2018).

In addition to their rich flavonoid content, which represents a significant class of secondary metabolites, medicinal plants provide other important sources of essential mineral elements.

Despite the growing popularity of herbal medicines, many commercially available liquid herbal formulations lack adequate quality control documentation, particularly concerning their antioxidant effectiveness and physicochemical characteristics. This study addresses this gap by evaluating the antioxidant capacity of selected liquid herbal products through the 1,1-diphenyl-2-picrylhydrazyl (DPPH) analytical approach.

1.2. Concept of Ultraviolet Visible Spectrophotometer

Spectrophotometry comprises techniques that measure how light interacts with different materials. When electromagnetic radiation encounters a substance, it may be reflected, transmitted, scattered, or absorbed. Simultaneously, the exposed material can re-emit the absorbed light at altered frequencies, resulting from either energy acquisition from the light source or thermal effects (Germer et al., 2014). Various spectrophotometric methods have become well-recognized and extensively utilized for identifying and quantifying compounds in research, industrial, and chemical laboratory applications. For example, in pharmacy, and chemistry, UV-visible spectrophotometry is basic technique to analyze the samples based on the application of the Beer- Lambert -Bouguer Law (Trunmbo *et al.,* 2013).

This analytical approach measures how substances absorb or allow passage of ultraviolet and visible light. The core principle involves selective absorption of certain wavelengths as light travels through a sample, while other wavelengths pass through. The absorption pattern provides valuable insights into the substance's molecular structure, concentration, and chemical characteristics. This technique has become popular due to its straightforward operation, rapid results, and affordability.

The region of interest in UV-visible spectroscopy typically ranges from 200 to 800 nanometer (nm). The UV region lies between 200 – 400 nm, while the visible region ranges from 400 - 800 nm (Franca *et al.,* 2017).

1.2.1. What is Ultraviolet Visible Spectroscopy

UV-visible spectroscopy encompasses analytical methods that measure either absorption or reflection of light within the ultraviolet spectrum and the complete adjacent visible electromagnetic range. This technique offers the advantages of being cost-effective and straightforward to implement, leading to its extensive adoption across various scientific disciplines with numerous practical applications

1.2.2. Interpretation of Ultraviolet Visible Spectrophotometer Output

When interpreting UV-visible spectrophotometer data, absorbance values are calculated by comparing the light intensity passing through the sample (I) against the original light intensity (I_0). This relationship is called transmittance (T), expressed mathematically as $T = I/I_0$.

The connection between absorbance and transmittance follows the equation: $A = -\log T$.

Consequently, the instrument measures transmittance and subsequently calculates absorbance for display. Higher absorbance indicates less light transmission, resulting in elevated output values. The Beer-Lambert law provides another approach for absorbance measurement using the relationship E = A/C, where absorbance correlates directly with concentration (Skoog et al., 2007).

Table 1.1. Strength and Limitations of Ultraviolet Visible Spectrophotometry

S/N	Strengths	Limitations
1.	Easy to use	It doesn't work for all substances.
2.	Fast and gives quick results.	Impurities or solvents can affect results.
3.	Not expensive	It can't give full strength like NMR.
4.	It needs only small amount of sample	Only works if the sample absorbs UV or visible light

1.2.3. Applications of Ultraviolet Visible Spectrophotometer

i. Determining solute concentrations in liquid solutions.

ii. Serving as a detection system in High-Performance Liquid Chromatography (HPLC), where analyte presence produces signals proportional to concentration.

iii. Measuring thickness and optical characteristics of thin film layers in semiconductor manufacturing, including light reflectance assessments.

iv. Evaluating the color quality index of transformer insulating fluids (Pinheiro et al., 2004).

1.3. Overview of Organoleptic and Physicochemical Properties

1.3.1. Organoleptic Properties

Our senses play a crucial role in how we perceive substances. These sensory experiences are known as organoleptic properties. It refers to the methods of analysis like color (finish), aroma (smell), tastes (sweet, sour, salty, bitter) and texture (feel) with special features such as the eyes, nose and hands.

1.3.1.1. Importance of Organoleptic Properties

Organoleptic properties are crucial for:

i. Customer acceptance: They influence if an individual finds a product attractive or not as this may affect the consumer's adherence to the product.
ii. Quality control of product: change in these properties can indicate spoilage or contamination.
iii. Sensory evaluation to access product:Trained panels use them to assess and compare products.

1.3.2. Physicochemical Properties

Physicochemical properties of a product refer to the physical and chemical characteristics that help define the nature, identity, quality, and behavior of the substance under various conditions. These properties are essential in pharmaceutical, chemical, food etc. to assess stability, safety, efficacy and formulation design. Examples of such physicochemical properties include pH and specific gravity.

1.3.2.1. Importance of Physicochemical Properties

i Help in formulation development of drugs and herbal products.
ii Aid in quality control and standardization.
iii Determine storage conditions, shelf life, and packaging requirements.
iv Ensure bioavailability, safety, and efficacy of pharmaceutical products.

1.4. Herbal Products in Medicine

Herbal medicine, also called phytomedicine, involves studying medicinal plants (pharmacognosy) and their therapeutic application for treating diseases or promoting health maintenance. This approach forms the foundation of traditional medicine systems. Several factors drive the preference for traditional medicines: they typically cost less, align more closely with patients' cultural beliefs, address concerns about synthetic drug side effects, provide more personalized healthcare delivery, and offer better access to health information. Plant-based medicines find their primary use in health promotion and managing long-term conditions rather than treating acute, life-threatening situations. However, usage of traditional remedies increases when conventional medicines is ineffective in the treatment of diseases such as in advanced cancer and in the face of new infectious diseases (Qato*et al.,* 2008).

Herbal medicine products enjoy widespread popularity throughout Europe, with Germany and France representing the leading markets for over-the-counter herbal product sales among the European region. In developed countries generally, consumers can readily find essential oils, botanical extracts, and herbal infusions displayed alongside standard medications. Medicinal plants undergo various processing methods and can be administered in multiple formats, including whole herb preparations, infusions, syrups, essential oils, topical applications, and encapsulated or tablet forms containing ground, powdered, or dried extracted plant material.

Plants are rich in a variety of compounds, many are secondary metabolites and include aromatic substances, most of which are phenol or their oxygen substituted derivatives such as tannin, and others with antioxidant properties (Hartmann, 2007). About 200 years ago, scientists isolated morphine as the first pharmacologically active compound from opium, extracted from poppy seed capsules (*Papaver somniferum*). This discovery showed that drugs from plants can be purified and administered in precise dosages regardless of the source or age of the material. (Rousseaux and Schachter, 2003). This same methodology later enabled the development of important medicines including penicillin, digoxin, antimalarial drugs like quinine, and psychiatric medications such as reserpine.

1.4.1. Antioxidants and its Importance

Antioxidants occur naturally in plants, animals, and microorganisms, though they can be synthesized chemically. Natural antioxidants can be extracted from their biological sources as pure compounds for potential pharmaceutical applications. Higher plants and their components are particularly rich in natural antioxidants such as tocopherol and polyphenolic compounds, making plant materials an abundant source (Athukorala et al., 2003).

1.4.1.1. Importance of Antioxidants

i Reducing oxidative stress: When free radicals and antioxidants become imbalanced, oxidative stress develops, connecting to numerous chronic diseases. Antioxidants help minimize this stress and its harmful consequences.

ii Supporting overall health: Antioxidants play an essential role in maintaining general health and wellbeing by supporting normal body functions.

iii Protecting cellular structures: Antioxidants help shield cells from damage by free radicals, which can contribute to various disease processes.

iv Disease prevention: By reducing cellular damage and oxidative stress, antioxidants help lower the risk of certain diseases.

1.4.2. Mechanism of Action of Antioxidant Activity

An antioxidant is defined as a substance that can significantly delay or completely prevent the oxidation of substance molecules, even at low concentration (Gulcin*et al.,* 2010). They donate electrons to free

radicals, rendering them harmless, and neutralize them by minimizing oxidative damage in biological processes (Gulcin*et al.,* 2011; Shantabi*et al.,* 2014). Antioxidants prevent free radicals' formation by interfering with the free radical- mediated oxidative process at any of its three main stages: initiation, propagation and termination (Kendre *et al.,* 2011). The effectiveness of an antioxidant compound depends on different parameters and factors, this includes temperature, physical system state and properties of oxidation-sensitive substrate. (Gulcin*et al., 2*012). The chemical structure of an antioxidant molecule determines its intrinsic reactivity and antioxidant ability towards free radicals and other reactive oxygen species (Gulcin*et al.,* 2013). Antioxidant delay lipid peroxidation formation during storage and processing of foods, prevent deterioration of drugs and food products and extend the shelf life of products (Isik *et al.,* 2015). The concept of antioxidants and oxidative stress is often oversimplified. Specifically, reactive oxygen species are incorrectly treated as one unified entity. However, many distinct reactive oxygen species exist, each serving unique and necessary functions in normal body processes. Different reactive oxygen is strongly implicated in the etiology of diseases such as, cancers, atherosclerosis, neurodegenerative diseases, infections, chronic inflammatory, diabetes and autoimmune diseases (Halliwell, 2000). The body produces its own antioxidants (such as glutathione, thioredoxins, glutaredoxin, and various antioxidant enzymes), but these cannot generally substitute for one another. Each has specific chemical and biological characteristics that protect different parts of cells, organs, and tissues from oxidative damage. Dietary antioxidants also exist in various forms, with polyphenols and carotenoids being the largest groups of compounds produced by plants to protect plant cells against oxidative damage (Lindsay and Astley, 2002).

1.4.3. DPPH Free Radical Scavenging Assay

The 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay represents one of the most widely used approaches for evaluating antioxidant activity. This electron paramagnetic-based method serves as a primary screening tool for antioxidant assessment (Prior et al., 2005).

The DPPH assay works by measuring how antioxidants donate electrons to neutralize DPPH radicals. This reaction causes a color change in the DPPH solution, measured at 517 nm wavelength, with the degree of color loss indicating antioxidant strength. The DPPH method offers simplicity and requires only basic UV spectrophotometer equipment (Kedare et al., 2011). Lipid breakdown typically occurs through radical chain reactions. Radical scavengers improve food stability and quality by stopping these chain reactions. These scavenger molecules interact directly with harmful radicals and neutralize them quickly (Soares et al., 1997). The ability to neutralize free radicals holds great importance due to their damaging effects in food and pharmaceutical products. Researchers use many different tests to evaluate the antioxidant activity of plant extracts or phenolic compounds. When antioxidants are added to DPPH radicals, the purple color disappears through a mechanism that reverses DPPH formation (Gulcin et al., 2020; Gulcin et al., 2012).

1.5. Significance of the Study

This study aims to demonstrate scientific evidence for the antioxidant efficacy and quality of commonly used herbal products. The findings can help manufacturers improve product standardization, assist regulatory authorities in quality monitoring.

1.6. Aims and Objectives of the Study

Main Aim:

To evaluate the antioxidant capacity of selected herbal products available in Edo State.

Specific Objectives:

1. To measure the antioxidant activity of selected liquid herbal products using the DPPH assay method.
2. To examine the organoleptic characteristics (color, taste, smell, texture) of these herbal products.
3. To measure the specific gravity and viscosity of the herbal products as physicochemical quality indicators.

CHAPTER TWO

2.0. Materials and Methods

2.1. Materials: Sample Collection

Seven different selected herbal liquid herbal products were bought from the pharmacies and stores in Edo state in Nigeria. They include Mojeaga herbal remedy, Goodwills herbal mixture, Pro-life herbal remedy (malarial &typhoid), Evaking herbs (ulcer & pile removal), Ganacin-G7 (ulcer solution), Goko Cleanser and Orijin bitter. They were selected based on their ease of accessibility, affordability and popularity.

2.2. Methods

To prepare the working solutions, 100 mL serial dilutions were created using distilled water for each herbal product. From these dilutions, 1 mL was transferred into individual test tubes, then diluted with 9 mL of distilled water to achieve a final volume of 10 mL.

For the free radical solution, 0.04 g of DPPH was dissolved in 100 mL of methanol. Subsequently, 0.2 mL of this DPPH solution was added to each test tube containing the diluted herbal samples.

The reference standard was prepared by dissolving 0.1 g (100 mg) of ascorbic acid in 100 mL of distilled water. A 1 mL portion of this solution was transferred to a test tube and diluted with 9 mL of distilled water to reach a final volume of 10 mL. This standard solution then received 0.2 mL of the DPPH solution.

For the negative control, 10 mL of distilled water was placed in a test tube and combined with 0.2 mL of DPPH solution.

All test tubes were stored in complete darkness for 30 minutes to prevent light-induced degradation of the DPPH radical. Following the incubation period, the absorbance of each solution was measured at 517 nm using a spectrophotometer, and the values were recorded for analysis.

2.3. Labeled Claims and Organoleptic Properties

After purchasing the products, detailed information was recorded from product labels, including manufacturer's name and address, country of manufacture, batch numbers, production dates, expiration dates, and NAFDAC (National Agency of Food and Drugs Administration and Control) registration status where this information was available. The declared strength of each formulation was also documented.

An initial sensory evaluation was performed on all collected samples. The assessment covered color, taste, odor, and surface appearance (whether dull or glossy). When differences in these properties were observed among samples, conclusions were reached through consensus among at least two out of three independent assessors to ensure objectivity.

2.4. Physicochemical Properties of Herbal Products

2.2.1. pH

pH is a physicochemical property that helps to measure the acidity or alkalinity of a solution such as liquid herbal products. The pH scale uses 7 as the neutral point. Values below 7 indicate acidic solutions, while values above 7 indicate basic (alkaline) solutions.

2.2.2. Specific Gravity

Specific gravity represents a key physicochemical property, defined as the ratio of a substance's weight to the weight of an equal volume of water measured at a standard temperature (typically 4°C, where water density is 1.000 g/cm^3). In pharmaceutical and herbal formulations, specific gravity is used to assess the concentration of solutes present in a liquid, and it provides insight into the overall quality, strength, uniformity of a preparation. This parameter is especially valuable in quality control to monitor batch consistency of liquid herbal products and other pharmaceuticals products.

Formula for specific gravity:

Specific gravity = weight of liquid (e.g. herbal product) / weight of equal volume of water)

A 100 mL volume of distilled water was measured into a 100 mL volumetric flask, and the value was recorded.Thereafter, 100 mL of each liquid herbal product was measured into separate 100 mL volumetric flasks. This procedure was repeated for all seven liquid herbal products. The specific gravity of each sample was then calculated using the formula:

Specific Gravity = Weight of Sample /Weight of Water

Example:

Specific Gravity (g/mL) = 102.47/140.9 = 0.72

CHAPTER THREE

3.1. RESULTS AND DISCUSSION

3.2. Organoleptic Properties

Table 3.1 below presents the sensory properties of all selected liquid herbal products, including odor, taste, appearance, and color.

Sensory evaluation of plant-based remedies using human senses is called organoleptic assessment. This represents one of the simplest and most human relevant forms of analysis, involving evaluation of color, smell, and taste characteristics. The experiment showed that, most of the herbal liquids has strong herbal scent while Mojeaga herbal remedy and Goodswills herbal mixture has aromatic odour, The herbal liquids tasted bitter except Ulcer & pile removal tasted tasteless and Ganacin tasted sweet, while the colors are mostly brown except Ganacin and goko cleanser that showed moudy and dark color.

Table 3.1: Organoleptic Properties

Organoleptic Properties				
Product Name	**Odor**	**Taste**	**Finish**	**Color**
Mojeaga herbal remedy brown	Aromatic	Slightly bitter and woody	Dull	Dark
Goodswill herbal mixture brown	Aromatic	Slightly bitter	Dull	Deep
Pro-life herbal remedy brown (malaria & typhoid)	Strongly herbal	Slightly bitter	Dull	Light
Evaking herbs (pile & brown ulcer removal)	Strongly herbal	Tasteless	Dull	Light
Ganacin G-7 (ulcer solution)	Strongly herbal	Sweet	Dull	Moudy
Goko cleanser	Strongly herbal	Strongly bitter	Dark	Dark
Orijin bitters brown	Aromatic	Bitter-sweet	Dull	Deep

Table 3.2. below presents label properties of the products as well as information on the context of each herbal product including ingredients, volume of packaging material and also the product details. All products were manufactured within Nigeria. Regarding herbal product registration, the National Agency for Food and Drug Administration and Control (NAFDAC) has established guidelines and regulations to guarantee the safety, effectiveness, and quality of these products. It is important for manufacturers of herbal products and distributors to adhere to the rule's guidelines of NAFDAC to avoid product ban.

Table 3.2: Label Content and Product Details

Product Name	Ingredients	Volume	Product details			
			NAFDAC Reg	Man. Date	Exp. Date	Batch
Orijin bitters	Neutral spirit sugar, caramel, citric acid,	20 cL	08-0630	05/24	05/26	N/A

	trisodium citrate					
Mojeaga herbal remedy	*Alchornealaxiflora* – 4g, *Pennisetum purpureum* – 4g *Sorghum bicolor* – 4g	100 mL	A7-0996L	05/23	05/25	N/A
Goko cleanser	*Vernonia amygdalina*, *Zingiber officinale*, *Allium sativum*, *Saccharum officinarum*, *Cajanus cajan*, caramel, water	200 mL	A7-0804L	N/A	N/A	N/A
Ganacin-G7	*Ulmus Rubra*, Teracum, *Zingiber officinale, Mentha,Glycyrrhizaglabia*, *Allium sativum*, *Brassica oleracea*	N/A	N/A	05/24	04/27	005
Evaking herbs (ulcer & pile removal)	*Moringa oleifera, Aloe vera, Allium sativum*, *Cinnamomum zeylanicum*, water	500 mL	A7-4833L	04/07/23	03/03/27	001
Pro-life (malaria & typhoid)	Root, Herbal, *Azadirachta indica*, *Cymbopogon citratus*, preservatives, water	N/A	N/A	03/24	03/27	002
Goodswills herbal mixture	*Magnifera indica* - 5g, *Carica papaya* - 3g, *Psidium gaujoba* - 6.9g, Breadfruit -11.11g, *Masulariaacumnate* -4.4g, Citrus Lemon - 2.22g, *Zingiber officinale* -2.22g, *Cymbopogon spp*- 3.33g	500 mL	A7-0204L	04/23	04/26	0223D

3.3. Physicochemical Properties

3.3.1. pH

Table 3.3 below displays the pH values measured for each herbal product. They all had an acidic pH, (ranging from 3.8 to 4.8) except Orijin bitters which had alkaline pH (6.96) as shown in the table. Determining the ideal pH range for herbal liquid preparations, some general considerations can guide the selection of an appropriate pH which includes the stability and preservation, the compatibility with human body, the ingredients stability and product efficacy (Brusie, 2017).

Table 3.3: pH Values of Selected Herbal Products

S/N	Name of Product	pH Value
1.	Ganacin	4.87
2.	Goodswill	4.30
3.	Pro-life	5.00
4.	Mojeaga	6.60
5.	Evaking herbs	6.14
6.	Goko cleanser	3.10
7.	Orijin bitters	6.96

3.2.2. Specific gravity

Table 3.4 below presents the specific gravity measurements (g/mL) for the selected liquid herbal products. Specific gravity determination in herbal medicine plays an important role in quality control and standardization. Research studies measure specific gravity of crude plant materials, extracts, and essential oils to verify authenticity, ensure consistency, and confirm purity. The experimental results showed that the different selected herbal liquids exhibited specific gravity values ranging from 0.72 to 1.01 g/mL.

Table 3.4: Specific gravity (g/mL)

S/N	Name of Product	Sp (g/mL) Value
1.	Ganacin	1.01
2.	Goodswill	1.02
3.	Pro-life	0.99
4.	Mojeaga	0.72
5.	Evaking herbs	0.75

6.	Goko cleanser	0.74
7.	Orijin bitters	1.83

3.2.3. Viscosity

Viscosity (cp) is a measure of a fluid's rate dependent resistance to change in movement; it helps to determine if flow rate of other liquids is higher or lower than viscosity of water. The graph below shows the viscosity of the selected herbal products. The results obtained from the experiment indicates that all the selected liquid herbal products are less viscous, indicating they are free flowing liquids with recorded values that ranges from (2805 cp to 5748 cp).

Figure 3.1: Viscosity of selected herbal products

3.2.4. Percentage Inhibition

The graph below illustrates the percentage inhibition values for the selected liquid herbal products. Percentage inhibition was calculated by comparing the absorbance values of the test samples against the control.

The calculation formula used was:

Inhibition (%) = (Absorbance of control - Absorbance of sample) ÷ Absorbance of control × 100

Example:

Goodwills absorbance = 0.013

Control absorbance (DPPH & water) = 0.023

Inhibition (%) = (0.023 - 0.013) ÷ 0.023 = 43.48%

DPPH radical scavenging ability is widely used as an index to evaluate the antioxidant potentials of medicinal liquid herbal products (Kumbhare *et al.,*2012).

The selected liquid herbal products used for this experiment as indicated in their packing materials are used for management of different disease conditions such as, detoxification, treatment of ulcer, bacteria infections, anaemia, pile removal etc.

From the results obtained, all the liquid herbs showed a percentage inhibition that ranges from 39.13% to 56.2%, indicating good antioxidant property in comparison with the standard Ascorbic acid with a percentage inhibition of 73.91%, The ability of these products to scavenge free radicals may be attributed to the the presence of notable phytochemicals such as flavonoid, tannins, phenolics (Muanya*et al.,* 2008).

Figure3.2: The percentage inhibition of the selected liquid herbal products

CHAPTER FOUR

4.0. CONCLUSION

This study's results demonstrate that the selected liquid herbal products exhibit valuable physicochemical characteristics and antioxidant properties that may enhance their therapeutic value. All tested samples showed acidic pH levels, high viscosity, and notable antioxidant activity, which supports their potential use as natural health formulations. However, the observed variations in odor, taste, color, and specific gravity among products suggest differences in formulation approaches and possible inconsistencies in quality control practices.

Future research should focus on identifying the specific bioactive compounds responsible for the observed antioxidant activity and establishing standardized quality parameters to ensure the safety, efficacy, and consistency of these herbal products.

REFERENCES

Bielawska-Pohl A, Dzimitrowicz A, Greda K, Jamroz P, Lesniewicz A, Pohl P, Szymczycha-Madeja A and Welna M. (2018). Understanding element composition of medicinal plants used in herbalism—A case study by analytical atomic spectrometry.

Brusie, C. (2017) "Is tea acidic? Know the facts", Healthline, 24 October. Available at: https://www.healthline.com/health/food-nutrition/is-tea-acidic (Accessed: 6 November 2025).

Franca, Adriana S, Nollet and Leo M.L. (2017). Spectroscopic methods in food analysis. CRC. Press. Page 664.

Germer TA, Zwinkels JC and Tsai BK. Theoretical concepts in Experimental Methods in the Physical
spectrophotometric measurements. Sciences. (2014); 46:11-66.

Gulcin, I. Antioxidant activity of food constituents: An overview. *Archives. Toxicology* (2012), 86, 345–391.

Gulcin, I. Antioxidants and antioxidant methods-An updated overview. *Archives. Toxicology*. (2020), 94, 651–715.

Gulcin, I.; Elias, R.; Gepdiremen, A.; Chea, A. and Topal, F. Antioxidant activity of bisbenzylisoquinoline alkaloids from Stephania rotunda: Cepharanthine and fangchinoline. *J. Enzyme. Inhibition. Medicine. Chemistry*. (2010), 25, 44–53.

Gulcin, I.; Topal, F.; Ozturk Sarikaya, S.B.; Bursal, E.; Gören, A.C. and Bilsel, M. Polyphenol contents and antioxidant properties of medlar (Mespilus germanica L.). *Record. Natural. Products*. (2011), 5, 158–175.

Gocer, H. and Gulcin, I. Caffeic acid phenethyl ester (CAPE): Correlation of structure and antioxidant
properties. *International. Journal. Food Science Nutrition* (2011), 62, 821–825.

Gulcin, I.; Beydemir, S.; Topal, F.; Gagua, N.; Bakuridze, A.; Bayram, R. and Gepdiremen, A. Apoptotic, antioxidant and antiradical effects of majdine and isomajdine from Vinca herbaceaWaldst. and kit. *J.*
Enzyme. Inhibition. Medicine. Chemistry. (2012), 27, 587–594

Gulcin, I.; Elmastas, M. and Aboul-Enein, H.Y. Antioxidant activity of clove oil-A powerful antioxidant
source. *Arabic Journal. Chemistry. (2012),* 5, 489–499.

Gulcin, I. and Beydemir, S. Phenolic compounds as antioxidants: Carbonic anhydrase isoenzymes inhibitors. *Minimal Review. Medicinal. Chemistry*. (2013), 13, 408–430.

Halliwell B. The antioxidant paradox. Lancet. (2000) 335: 1179-1180.

Hartmann T. From waste products to Economic chemicals: Fifty years research of plant secondary metabolism. Phytochemical. (2007); 68:2831-46.

Henry, G. and Garner, W.L. (2003). Inflammatory mediators in wound healing. *Surgerical Clinic North*
America 83(3): 483-507.

Halliwell B. and Whiteman M. (2004) Measuring reactive species and oxidative damage in vivo and in cell culture: how should you do it and what do the results mean? *Britishb Journal Pharmacology* 142: 231–255.

Isık, M.; Korkmaz, M.; Bursal, E.; Gulcin, I.; Koksal, E. and Tohma, H. Determination of antioxidant properties of Gypsophila bitlisensis. *International Journal Pharmacology* (2015), 11, 366–371.

Kedare, S.B. and Sing, R.P. Genesis and development of DPPH method of antioxidant assay. *Journal Food Science Technology*. 2011, 48, 412–422.

Kumbhare, MR, Guleha V. and Svakumar, T. (2012). Estimation of Total Phenolic Content, *Cytotoxicity and Pacific Journal of Tropical Diseases*,2(2):144 –150.

Lindsay D.G and Astley S.B. European research on the functional effects of dietary antioxidants. EUROFEDA. *Molecular Aspects Medicine*. (2002): 231:1-38.

Muanya CA and Odukoya OA (2008) Lipid peroxidation as index of activity in aphrodisiac herbs. Journal Plant Science 3(1):92–98.

Najla.BE and Hamida-Ferhat A. (2022). Analytical approaches used in the profiling of natural products with a therapeutic target: a global perspective on nutrition and health. *Studies in Natural products Chemistry,* 72, 1-40.

O.J. Akinjogunla, N.O. Eghafona, I.O. Enabulele, C.L. Mboto, and F.O. Ogbemudia. Antibacterial activity of ethanolic extracts of Phyllanthus amarus against extended spectrum B-lactamase producing Escherichia coli from stool samples of HIV Sero-positive patients with or without diarrhea. *African Journal Pharmacol*, 4 (2010), pp. 402-407.

Pakade, V., Cukrowska, E. and Chimuka, L. (2013). Comparison of antioxidant activity of Moringa oleifera and selected vegetables in South Africa. *South African Journal of Science*, 109 (3): 1154-1155.

Prior RL and WuX and Schaich K (2005) Standardized methods for the determination of antioxidant capacity and phenolics in foods and dietary supplements. *Journal Agricultural Food Chemistry* 53(10):4290-4302.

Pinheiro, H.M, E., Touraud, and O. Thomas, Aromatic amines from dye reduction status review with emphasis on direct UV Spectrophotometric detection in textile industry wastewaters dyes and pigment, (2004). 61(2): p.121-139.

Qato D.M, Alexander G, C, Conti R, M, Johnson M, Schumm P and Lindaus S. T. Use of prescription and over -the - counter medications and dietary supplements among older adults in the United States. *Journal of the America Medical Association*. (2008); 300:2867-78.

Rousseaux C.G and Schachter H. Regulatory issues concerning the safety, efficacy and quality of herbal remedies. *Birth Defects Research Bulletin* (2003); 68:505-10.

Soares, J.R.; Dinis, T.C.; Cunha, A.P. and Almeida, L.M. Antioxidant activities of some extracts of Thymus zygology Free *Radical. Research.* (1997), 26, 469–478.

Shantabi, L, Jagetia, G.C, ALi, M.A, Singh, T.T and Devi, S.V. Antioxidant potential of croton caudatus leaf extract in vitro. *Translation. Medical. Biotechnol* (2014.) 2, 1-15.

Skoog, Douglas A., Holler, F. James., Crouch and Stanley R. (2007). Principles of instrumental analysis (6th edition). 169-173.

Trumbo TA, Schultz E, Borland MG and pugh ME. Applied Spectrophotometry, Analysis of a biochemical mixture. *Biochemistry and Molecular Biology Education* (Wiley Online Library). (2013);41(4):242-250

Upadhyay A, Upadhyay K and Nath N. Biophysical Chemistry (Principals andTechniques). Girgaon, Mumbai, India: Himalaya Pub House;(2009). International standard Book Number ISBN: 1282802003 9781282802001

World Health Organization. (2023). Traditional medicine. https://www.who.int/news-room/questions-and-answers/item/traditional-medicine.

World Health Organization. (2023). Traditional, Complementary and Integrative Medicine.

Y. Athukorala, K.W. Lee, Song C., C.B. Ahn, T.S. Shin, Y.J. Cha F. Shahidi and Jeon (2003). Potential antioxidant activity of marine red alga Grateloupiafilicina extracts. *Journal of foods lipids*, 10, pp.251-263.

Zwinkels J. In: Luo R, editor. Light, Technology. New York: S*pringer Science Encyclopedia of Color Science and and Business Media*;(2015). DOI: Electromagnetic Spectrum. 10.1007/978-3-642-27851-8_204-1.

APPENDIX

Samples	Absorbance (at 517 nm)	% Inhibition
Ganacin-G7	0.012	47.83
Goodswill	0.013	43.48
Pro-life	0.010	56.52
Mojeaga	0.013	43.48
Evaking Herbs	0.008	65.22
Goko Cleanser	0.014	39.13
Orijin Bitters	0.010	56.52
Vitamin C (control) + DPPH	0.006	73.91
Water + DPPH	0.023	

Samples	Viscosity
Ganacin-G7	5748
Goodswill	4434
Pro-life	2805
Mojeaga	3636
Evaking Herbs	5337
Goko Cleanser	4002
Orijin Bitters	4026