STUDY ON THE USE OF INDIGENOUS PLANTS' PARTS FOR FOOD PRESERVATION AMONG FARMERS IN IVO LGA, EBONYI STATE

BY

ADIRUO, AKUNNA STEPHANIE (B.TECH, FUTO, PGDE, NOUN)
20174081888

A THESIS SUBMITTED TO THE POST GRADUATE SCHOOL, FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PUBLIC HEALTH (MPH) DEGREE

JULY, 2023

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CERTIFICATION

This thesis on Study on the Use of Indigenous Plants' Parts for Food Preservation among Farmers in Ivo LGA, Ebonyi State written by Adiruo, Akunna Stephanie (Reg. No: 20174081888) has been certified as meeting the requirements for Master's Degree thesis in Public Health, in Post Graduate School, Federal University of Technology, Owerri.

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DEDICATION

This work is dedicated to my husband – Engr. Henry Adiruo and my children – Ihuoma, Oluebube, Chiemerie and Chimeremma.

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ABSTRACT

This research work focused on "Study on the use of indigenous plants' parts for food preservation among farmers in Ivo LGA, Ebonyi State". The study employed a cross sectional descriptive survey design. The sample size comprised three hundred and six (396) farmers selected through multi-stage sampling technique. The researcher's structured questionnaire was the instrument used for data collection, data generated were analyzed using frequency, mean and standard deviation as well as inferential statistics of ANOVA at 0.05 level of significance at appropriate degree of freedom. Analysis of data was done with the SPSS version 23. The result revealed that majority were knowledgeable of the alternate preservation of food with indigenous plants, 65.1% positively perceived the use of indigenous plants for food preservation while 93.2% used indigenous plants for food preservation. Results also revealed that more than half of the respondents were knowledgeable that chilli pepper can be used to preserve dried form of rice (57.1%), beans (78.8%), maize (71.5%) and melon (57.3%) for more than 6 months duration. More than half of the respondents (66.3%) attested to bitter leaf efficacy in preserving some food items like fresh form of cassava for duration of 8 days to 1 month. The study also revealed that there was significant difference in utilisation of the indigenous plants among sexes, different age groups, levels of education, years of farming experience, type of farming practiced and level of income. Based on the findings, the study recommended among others that these indigenous plants parts should be processed to obtain forms and products that will substitute the chemical preservatives in the market because most consumers would show higher preference for products preserved with natural products. Neglecting this can lead to a negative setback for the farmers and local people which could result in decreasing interest on the use of these natural food preservatives. Future research should focus on the promotion of indigenous plants so that they can know their importance in addressing food and nutrition security.

Keywords: Study, **i**ndigenous plant parts, food preservation, farmers, Ivo LGA
Word count: 328

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Operational Definition of Terms

Knowledge: Knowledge is used to cover such related terms as facts, information, understanding, awareness, insight, wisdom, reasons, comprehension, meaning, concept and experience.

Perception: Perception refers to how people think, believe and the way they view and understand things**.**

Utilization: It refers to action of making practical and effective use of something**.**

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Food borne illness caused by consumption of foods contaminated with micro-organisms or their toxins has been of great public health concern. In recent times, consumers are even more concerned of the processed foods they eat not only because of the high risk of contamination but also because of the added synthetic preservatives which may be hazardous to health. Food additives such as monosodium glutamate, aspartame, saccharin, sodium cyclamate, sulfites, nitrates, nitrites and antibiotics have all been reported to cause clinical conditions manifesting variously as headache, nausea, weakness, mental retardation, seizures, cancer and anorexia (Rangan & Barceloux, 2019; Wroblewska, 2009). The increasing demand for food with longer shelf life, food with little or no chemical preservatives coupled with the concern about toxic effects of some preservatives has resulted in increased pressure to find alternatives for better healthcare. Consequently, there is a considerable interest to stop the disease outbreaks caused by pathogenic and/or spoilage food microorganisms among food processors, food safety researchers and regulatory agencies (Marija & Nevena, 2019). Antimicrobial agents of plant origin have been documented and spices are among those perceived to have great potentials for use as antimicrobial agents (Arora & Kaur, 2019; Okeke et al., 2011).

Food crops and plant products need to be protected against biodegrading agents such as pest, fungi, bacteria and nematodes e.t.c. Preservation of plant products is important in order to increase the shelf life of the plants. Most plants and plant products are easily infected by pest, some easily break up and this leads to their destruction which makes them unfit for human use. Thus, the use of preservatives is highly imperative. Plants like for example Capsicum fructesan,

Vernona amygdalina and Azadirachta indica were promising examples of plants used for pest control and as a source of insecticide (National Research Council [NRC], 2012). Preservatives are chemical or natural ingredients usually added to plant products to protect against decay or decomposition (Rosenthal et al, 2009) or to prevent spoilage (Pandey, 2002).

About 50% of total crops are lost annually because of insect and pest attacks, which adversely affect world food production and huge economic losses (Food and Agriculture Organization of the United Nations, [FAO], 2017; Rahman et al., 2016). The use of pesticides has contributed immensely to the increase in agricultural productivity; however, these pesticides lead to serious environmental pollution, affecting human health and causing the death of non-target organisms (Biswas, Rahman, Kobir, Ferdous & Banu, 2014). There is now an increasing trend in the use of botanicals with more than 2400 bioactive medicinal plant species identified for their pesticide and antipathogenic properties (Karunamoorthi, 2012).

The use of plants as preservatives over synthetic preservation is receiving more attention nowadays, this is because plants were found to be natural, cheaper, they are holistic in nature, easy to get and does not need the presence of skilled personnel before administration (Rees & Banks, 2001; Olanipekun, 2011). Incidentally, in Nigeria, the preservative potentials of many plants have been known for a long time by the rural dwellers and the natural pesticides found embedded in plants have been used for pest control in rural areas. Akinwumi et al, (2006) reported that the use of plant materials as preservatives have shown that treated fish do not exhibit adverse evidence of smell or change in taste, texture or flavor. Consequent on the above, it is therefore important to identify different plants used as preservatives and to propose sustainable strategies for the conservation of endangered species.

Allium cepa (common onion), usually thought of as a vegetable, has a long medicinal use history. Principally, the fleshy bulb is used as medicine and as food; but other parts of the plant have also been used in traditional medicine for the treatment of various ailments (Azu et al., 2017). The fruits of the guinea pepper (Piper guineense, Uziza in Igbo) and seeds of the African pepper (Xylopia aethiopica, Uda in Igbo) are common spices and condiments included in a variety of indigenous Nigerian recipes particularly among the Igbos of southern Nigeria (Okeke et al., 2011). In a survey, respondents in the region indicated that the two spices act as stimulants and laxatives, used to smoothen the skin and cure fever, cough and stomach disorders. They are also used as abortificients to treat amenoria and cleanse the womb after childbirth (Okeke, 2008).

Studies in the past decades confirm that the growth of both Gram-negative and Gram-positive food borne bacteria, yeasts and mold can be inhibited by spices (Eruteya & Odunfa, 2019). *Monodora myristica*, *Piper guineense* and *Xylopia aethiopica* were screened for fungitoxic activity of their essential oils against mycelial growth of 3 food contaminants, *Aspergillus fumigatus, Aspergillus nidulans* and *Mucor hiemalis*. The essential oils from all the spices were fungi-toxic to varying degrees (Nwaiwu & Imo, 2009). Johnson and Vaugh (2009) reported the inhibitory activity of reconstituted onion and garlic preparations against *Salmonella typhimurium* and *Escherichia coli*. According to Shelef (2013) garlic inhibited *Salmonella typhymurium, Escherichia coli, Staphylococcus aureus, Bacillus cereus, Bacillus subtilis, mycotoxigenic Aspergillus* and *Candida albicans*.

However, there is paucity of information on the phytochemical compositions, antioxidant and antimicrobial properties of many Nigerian spices which have been in use for centuries as flavouring ingredients as well as important properties for broader application in food processing and preservation in many

traditional dishes. The study is therefore designed to examine the perception and knowledge of rural dwellers on the use of indigenous plant extracts as food preservatives.

Therefore the following research questions were formulated to guide the study:

1. What is the level of knowledge of alternative preservation of food with indigenous plants parts among farmers in Ivo LGA, Ebonyi State?
2. What is the knowledge of type of food Preserved with Indigenous Plant Parts and the Duration among farmers in Ivo LGA, Ebonyi State?
3. What is the perception on the use of indigenous plants for food preservation among farmers in Ivo LGA, Ebonyi State?
4. What is the utilization of plant parts for food preservation among farmers in Ivo LGA, Ebonyi State?
5. What are types of indigenous plants utilized for food preservation among farmers in Ivo LGA, Ebonyi State?

1.2 Statement of the Problem

Considering the health effects of chemical and the increasing death resulting from food preserved with chemicals. It is paramount we consider cheap and friendly means to preservation. These will discourage chemical use in food preservation.

To prevent food spoilage, several physical and chemical preservation techniques are commonly employed. Nowadays, there is an increasing consumer awareness concerning the use of processed food having no chemical preservatives. The trend of today is the use of natural additives or preservatives instead of any chemical additives.

Plants and spices are excellent sources of biologically active compounds with potential antimicrobial activity. They can be extracted from different parts of

plants, including flowers, roots, bark, leaves, seeds, peel, fruits, wood, buds and the entire plant. Currently permitted synthetic preservative are still being used safely and successfully, to prevent bacterial spoilage of processed food. Increasing consumers demand for green food products with high safety and nutritional values, the present research focuses on using plant sources to meet this need, diversify their use as natural preservatives and as culinary spices that contain active ingredients that promote health and reduce the risk of diseases.

The paucity of knowledge and perception of the phytochemical constituents, antioxidant and antimicrobial properties of these indigenous herbs and spices has resulted in their neglect and underutilization. It is envisaged that the result of this study will initiate the exploitation of the preservative, nutraceutical and therapeutic potentials of these culinary herbs and spices.

Indigenous knowledge is the main sources of all ethnobotanical investigations. However, the continuation of this knowledge is endangered. Therefore, the study looked at the use of indigenous plants in the food preservation among farmers in Ivo LGA, Ebonyi State.

1.3.1 Objectives of the Study

The overall objective of this study was on the use of indigenous plants' parts for food Preservation among farmers in Ivo LGA, Ebonyi State.

1.3.2 Specific Objectives

In order to achieve the study overall objectives, the following specific objectives were stated below:

1. To assess the level of knowledge of alternative preservation of food with indigenous plants parts among farmers in Ivo LGA, Ebonyi State.
2. To determine knowledge of type of food Preserved with Indigenous Plant Parts and the Duration among farmers in Ivo LGA, Ebonyi State.

3. To ascertain the perception on the use of indigenous plants for food preservation among farmers in Ivo LGA, Ebonyi State.
4. To determine the utilization of plant parts for food preservation among farmers in Ivo LGA, Ebonyi State.
5. To determine type of indigenous plants used for food preservation among farmers in Ivo LGA, Ebonyi State.

1.4 Research Hypotheses

The following null hypotheses were postulated and tested at 0.05 level of significance.

1. There is no statistically significant difference in the utilization of indigenous plants for food preservation by farmers according to gender.
2. There is no statistically significant difference in the utilization of indigenous plants for food preservation by farmers according to age group.
3. There is no statistically significant difference in the utilization of indigenous plants for food preservation by farmers according to level of education.
4. There is no statistically significant difference in the utilization of indigenous plants for food preservation by farmers according to years of farming experience.
5. There is no statistically significant difference in the utilization of indigenous plants for food preservation by farmers according to type of farming practiced.

1.5 Justification of Study

This study will provide detailed information on knowledge and perception of indigenous plants parts for broader application in foods and other relevant areas.

The findings of this study will be beneficial to the following: food vendors, Management of food industries, government, public and other researchers.

To food vendors, it will create awareness of alternative ways of preserving food, prevent food borne diseases and other health problems associated with artificial food preservatives, thereby promoting health and achieve optimum wellness for their customers.

The findings of the study would help the management of food industries to initiate the exploitation of the preservative, nutraceutical and therapeutic potentials of indigenous plants for food preservation. The findings will encourage the government to enact policies that will help NAFDAC to enforce food industries to harness the wholeness nature and safety qualities of indigenous plants for food preservation.

To the public, it will be helpful in creating awareness on the good health implications of using indigenous plants. This would influence them in advocating for its use. It would enrich literature for other researchers.

1.6 Scope of the Study

The study was delimited to the use of indigenous plants'parts for food Preservation among farmers in Ivo LGA, Ebonyi State. This study was a descriptive quantitative study. The study participants were selected based on their wealth of knowledge or experience relating to the focus of inquiry. In this research, both women and men were chosen as participants, as are intimately connected to the food system. This can be seen both biologically and in

responsibilities in the private sphere, where they are greatly involved in the production, purchasing, and preparation of food. ADP contact farmers in the area were sampled using multistage sampling techniques. The participants were selected from age range between 25 and 50 years. The study was delimited to the use of independent variables of age, gender, size of farm, education, monthly income and years of experience. The study was delimited to qualitative descriptive survey design. The research was also further delimited to the use of questionnaire as instruments for data collection. It was finally delimited to the use of descriptive statistics of frequency, mean and standard deviation to answer the research questions as well as inferential statistics of ANOVA to test the null hypotheses at 0.05 level of significance at appropriate degree of freedom.

CHAPTER TWO

LITERATURE REVIEW

This chapter dealt with the review of literature considered important to this study. The literature review was discussed under the following sub-headings:

2.1 Conceptual Framework
2.2 Theoretical Framework
2.3 Empirical studies
2.4 Review of Reviewed Literature

2.1 Conceptual Framework

2.1.1 Concept of knowledge

Knowledge is defined as the sum of conceptions, views and propositions which have been established and tested (Conforth, 2006). Hornby (2009) conceived knowledge as the accumulated facts, truths, principles and information to which the human mind has access. He emphasized that knowledge is the outcome of specified rigorous enquiry, which originated within the frame work of human experience. He concluded that knowledge could be seen as the product of the operation of man's intellect, either within or apart from human experience. Omoregbe (2008) refers to knowledge as the awareness of factors associated with something. This means that for a person to be knowledgeable of something, he or she must be aware of the property of the object, event or situation. Knowledge means the information, understanding and skills that one

gains through education or experience (Hornby, 2011).

Kant (2010) stated that we need sense – perception as well as reason to produce knowledge. He made this clear by projecting the three things that are involved in the act of sense – perception that give rises to knowledge namely; the object perceived, the sense organ with which it is perceived, and the ego or consciousness or, the subject that interprets what is perceived and gives it a meaning. Mouskin and Miller (2010) stated that it is essential to determine both the extent and quality of knowledge that a person has about a particular issue. This, according to them, is because knowledge is instrumental in accepting or resisting any change. Mba (2001) argued that one of man's greatest enemies is ignorance. He maintained that knowledge will give one necessary power and put one in the appropriate frame of mind for positive attitude and practice.

Knowledge can be classified into empirical knowledge, inferential knowledge, intuitive knowledge and priori knowledge. Empirical knowledge is the knowledge acquired through sense – perception, that is, through any of the five senses (Omeregbe, 2008). Inferential knowledge is the type of knowledge that is acquired by inference. The intuitive knowledge is knowledge gained by an immediate contact of the mind with the object without going through the process of reasoning (Omoregbe, 2008). Kant (2010) described priori knowledge as knowledge acquired prior to experience and independently of experience. In other words, it is knowledge acquired without experience.

The hierarchy of Bloom's Taxonomy of educational objectives as asserted by Opara (2003) revealed that knowledge is acquired and utilized from simple to a more complex form. This involves knowledge of facts, understanding of information, its application to solve daily life problems, analysis and synthesis of facts, and final evaluation of the result. According to him, dealing with health behaviour from the perspective of knowledge and how it influences behaviour is a multidimensional problem because of the various alternatives that exist in the knowledge component.

Knowledge according to Winifred (2009) is accumulated facts, truths, principles and information to which human mind has access. Knowledge can be defined as the sum of conceptions, views and prepositions which has been established and tested (Conforth, 2016). In the context of this study, knowledge refers to the act of having adequate information and understanding of the utilization of medicinal plants by famers.

2.1.2 Concept of Perception

Perception is the process by which organisms interpret and organize sensation to produce a meaningful experience of the world. Sensation usually refers to the immediate, relatively unprocessed result of stimulation of sensory receptors in the eyes, nose, tongue or skin (Lambert, 2008). Perception, on the other hand, better describes one's ultimate experience of the world and typically involves further processing of sensory input (Agu, 2010). According to Hornby (2013),

perceiving is the process of using the senses to acquire information about the surrounding environment or situation. It is an impression, an attitude or understanding of what is observed or thought. In the context of this study, perception refers to feelings, opinion, of secondary school students about health outcomes of unwanted pregnancy; the way in which students see, understand, and interpret influence of health outcomes of unwanted pregnancies. Different people perceive the same situation differently (Katz, 2011). Understanding perceptions is vital as perceptions influence uptake of healthy behaviour practice.

2.1.3 Concept of Utilization

Utilization is the action of using something, i.e., making practical and effective use of it. Put simply; the term refers to the use of something or the process of using it effectively. The Cambridge Dictionary has the following two definitions of the term: "The process of using something effectively."

The concept 'utilization' is the extent to which a product can be accessed to achieve specified goals with effectiveness; efficiency and satisfaction in a specified extent of consumption (Hornby, 2015). Using medicinal plant is a common practice, but the skill of using these plant to the utmost is not so common.

Utilization literarily means to consume, in a layman's understanding. Medicinal

plant utilization therefore is the total amount of plant actually consumed compared to the amount of medicinal plant planned for a specific process. Utilization is the accessibility of a product, services, environment, or facility by people with widest range of capability. Oyediran-Tidings (2004) observed that there was low utilization of the medicinal plant by indigenous residents which was attributed to the expressed unavailability of research.

2.1.4 Food

Food is defined by World Health Organization (WHO) (2019), as any substance whether processed, semi-processed or raw which is intended for human consumption. This implies that food is both solid and liquid substance considered safe for human satisfaction of his body needs. In a similar way, Ohiokpehai (2014) describes food as anything liquid or sold material which when eaten and digested provides the body with needed nourishment. In this context, food is any type of juice, fruit and other materials that are eaten and considered safe for the satisfaction of the physiological needs of an individual. Food is a basic human need in the society. Good and adequate nutrition promote good health thereby enhancing the social and psychological well-being of the people.

Foods are organic substances which are consumed for nutritional purposes. Foods are plant or animal origin and contain moisture, protein, lipid, carbohydrate, minerals, and other organic substances. Foods undergo spoilage

due to microbial, chemical, or physical actions.

Food can be raw, processed or formulated materials consumed by human and animals to produce energy, promotes growth, and to maintain good health. In most cases, there are no limitations on food consumption. However, the excessive consumption of certain types of food such as fat, sugar and salt, may be harmful to health. Chemically, food products consist of water, fat, carbohydrates, protein and small amounts of organic compounds and minerals (Rahman, 2007). There are 6 classes of food based on the food pyramid, which are fats and sugar (cream, butter, sugar, soft drinks, and so on.), dairy products (yogurt, cheese, milk, and so on.), protein (poultry, eggs, meat, nuts, and so on.), vegetables (tomatoes, salad, spinach, and so on.), fruits (apples, mangoes, banana, and so on.) and lastly, carbohydrates (bread, rice, noodles, and so on.) (Ottoboni & Ottoboni, 2014).

2.1.5 Food preservation

Nutritional values, color, texture, and edibility of foods are susceptible to spoilage (Rahman, 2007). Therefore, foods are required to be preserved to retain their quality for longer period of time. Food preservation is defined as the processes or techniques undertaken in order to maintain internal and external factors which may cause food spoilage. The principal objective of food preservation is to increase its shelf life retaining original nutritional values, color, texture, and flavor.

The history of ‘Food Preservation’ dates back to ancient civilization when the primitive troupe first felt the necessity for preserving food after hunting a big animal, which could not be able to eat at a time. Knowing the techniques of preserving foods was the first and most important step toward establishing civilization. Different cultures at different times and locations used almost the similar basic techniques to preserve food items (Ottoboni & Ottoboni, 2014).

Conventional food preservation techniques like drying, freezing, chilling, pasteurization, and chemical preservation are being used comprehensively throughout the world. Scientific advancements and progresses are contributing to the evolution of existing technologies and innovation of the new ones (. Seetaramaiah et al., 2011).

Food preservation is the branch of food science and technology that deals with the practical control of factors capable of adversely affecting the safety, nutritive value, appearance, texture, flavor, and keeping qualities of raw and processed foods. Since thousands of food products differing in physical, chemical, and biological properties can undergo deterioration from such diverse causes as microorganisms, natural food enzymes, insects and rodents, industrial contaminants, heat, cold, light, oxygen, moisture, dryness, and storage time, food preservation methods differ widely and are optimized for specific products. Apart from application of a single food preservation method, a combination of methods may be used to improve the safety and storage stability of foods.

All food raw materials have biochemical processes and are susceptible to attack by microorganisms, which modify their sensory properties and can produce toxic substances. Fats, oils, flavoring substances, vitamins and colors spontaneously oxidize when exposed to air, and the antioxidants protect against this oxidation (Amorati, Foti & Valgimigli, 2013). There are a number of the factors that contribute to food oxidation, including the presence of oxygen, transition metals, moisture, heat and light. Oxygen and transition metals should be removed or sequestered to prevent, minimize or slow down the oxidation rate of food. Antioxidants are compounds that inhibit or retard the oxidative process, reducing changes in the taste, color and nutritive value of food (Shahidi & Zhong, 2010). The natural antioxidants used in food are ascorbic acid, carotenoids, phenolic compounds and tocopherols (Choe & Min, 2019).

2.1.5.1 Antioxidants

Antioxidant agents are commonly being used to extend the food shelf life by preventing the oxidative rancidity, degradation and also changing colour of food from occurring. The natural antioxidant is act as free radical scavengers should consist the phenolic compounds, vitamin C and vitamin E (Skurtys et al., 2011). Problems that usually facing by seller are the presence of undesirable melanosis on the surface of fresh-cut fruits and vegetables. These will change in the appearance of fruits and vegetables. This is because the reaction occurred on their surface. During this reaction there are two types of enzymes that are

involved which are polyphenoloxidase (PPO) and peroxidase (POD) as catalysts. Initially, the hydroxylation will slowly take place which will change the monophenols compounds to diphenols. The second reaction, oxidation of diphenols to quinines will occur and as the results, brownish colour will appear on the fruits or vegetable surface. All these reactions will be held only when the products are being surrounded with the presence of oxygen. The process of handling will be one of the reasons that lead to the beginning of melanosis reaction and the deterioration of foods will occur (Ioannou & Ghoul, 2013). While for poultry, meat, and fish they will face the problem on the lipid oxidation. Most of the lipid oxidation occurred is due to the oxidation of myoglobin species and hemoglobin in the fish muscle (Dwivedi,Vasavada, & Cornforth, 2006).

The term antioxidant is associated with the effect of an antioxidant on a specific medium dependent of factors such as chemical reactivity, location at cellular level, concentration, mobility, interactions with free radicals, absorption, distribution, metabolism and excretion. Antioxidants are classified according to their mode of action, source or solubility (Vertuani, Angusti & Manfredini, 2004). According to their mode of action, antioxidants are grouped into five types: radical scavenging antioxidants or antioxidants that break the chain of radical propagation; chelators, which form complexes with metals and prevent them from initiating the formation of radicals; extinguishers, which deactivate

high-energy oxidant species; oxygen scavengers, which remove oxygen from the systems, preventing their destabilization; and finally, regenerators of antioxidants, which reconstitute other antioxidants present in the food when they become radicals.

The deterioration rate of a food can be influenced by the presence of endogenous antioxidants, the presence of oxygen and toxic substances susceptible to oxidation, temperature, pH and light. Oxidation can be avoided or retarded by various media, for example by replacing air with inert gases during packaging, using enzymes that consume the oxygen present in the medium, incorporating UV radiation-absorbing substances into packaging and using cooling systems. These media are sometimes not sufficient to prolong the shelf life of some foods. For this reason, the use of exogenous antioxidants in food has become essential to retard oxidative deterioration and prolong its useful life. Antioxidants have specific properties and are more effective in some applications than others (Saltmarsh, 2013). A combination of two or more antioxidants is more effective than individual use, thus favoring the synergistic effects that enhance the activity of antioxidants. The use of antioxidant extracts can be very effective in food preservation.

Natural antioxidants have beneficial effects against neurodegenerative diseases induced by oxidative stress. Phenolic compounds are the most important group of natural antioxidant compounds, because they have strong antioxidant activity

and important beneficial effects on human health. Among the most important effects are anticancer and antidiabetic activities. These compounds also help prevent cardiovascular, brain diseases and regulate the immune system (Carocho & Ferreira, 2013).

Plant is one of source of antioxidant agent due to the presence of various types of active compound. Antioxidant compounds are usually can be found in spices, citrus pulp, peel and oil seeds. As examples, black pepper, turmeric, garlic, and so forth is capable of hindering the antioxidant properties in distinct types of food systems. Most of the spices have the ability in antioxidant is because of the presence of active compounds such as lignans, flavonoids, polyphenolic and terpenoids. Recent years, essential oils are famously being chosen to be used as the antioxidant agent for food preservation due to present of antioxidant compound. These compounds are capable of hindering or postponing the oxidation of lipid for poultry, meat and fish. They will hinder the chain reaction of the oxidation. The presence of the majority compounds of phenolic in essential oils is the main reasons for it being used in food preservation which it will be accountable for antioxidant properties (Marin, Sayas-Baebera, Viuda-Martos, Navarro & Sendra, 2016).

As reported by Nugboon and Intarapichet (2015), four types of Thai culinary herbs has been tested for their antioxidant properties which are holy basil, Vietnamese coriander, turmeric and green peppercorn. They will be used in

freeze-drying method for pork meatball batter and store it in vacuum packaging at 4^{o}C. As results, holy basil and green peppercorn show the longer shelf life comparable to turmeric and Vietnamese coriander. However, all the meatballs that have been tested with Thai herbs have extended shelf life compared to the control meatballs which it lasts less than 6 days. Studied that reported by Supapvanich, Prathaan, and Tepsorn (2012) shows that the used concentration ratio of 1:1 for pineapple fruit core extract is effective in order to delay the browning process compares to pulp and peel extract. The used of konjac glucomannan coating incorporated with the pineapple extract has the lowest polyphenol oxidase and peroxidase, but it contains high total phenols content.

Below is a description of other plant sources of antioxidants that are used or are potential additive antioxidants.

2.1.5.2 Antibacterial from bitter leaf

Bitter leaf (*Vernonia amygdalina*) is a popular shrub belonging to the family Asteraceae (Okwuzu et al., 2017). *V. amygdalinais* a perennial shrub commonly cultivated as a homestead vegetable and fodder tree (Ndaeyo, 2007).It is widely found in various parts of Nigeria. Bitter leaf is one of the leafy vegetables crucial in curbing micronutrient malnutrition (Tonukari et al., 2015). The plant is an essential protective vegetable and a popular ingredient used in making soup (Onabanjo & Oguntona, 2003; Shokunbi et al., 2011; Uchechukwu Anastasia, 2011). The leaves are widely considered appetizers and used to aid

digestion (Oyeyemi et al., 2018). It is beneficial for human health care and the treatment of various diseases. Bitter leaf is widely recognized due to the vast bioactive compounds obtained in various plant parts (Oyeyemi et al., 2018).

Research on the pharmacological potentials of V. amygdalina indicates that the plant possesses immunomodulatory activities (Setiawan et al., 2018), antimicrobial properties (Ijeh & Ejike, 2011; Salawu et al., 2011), antibacterial activity (Habtamu & Melaku, 2018), insecticidal properties (Green et al., 2017; Ileke Kayode & Olabimi Isaac, 2019), antidiabetic (Owen et al., 2011), anthelmintic (Nalule et al., 2011), anticancer (Izevbigie et al., 2008; Yedjou et al., 2015), antihelmitic and antimalarial properties (Oboh, 2006), anxiolytic, sedative and hypothermic effects (Oloruntobi et al., 2014). Although V. amygdalinahas been widely studied and its bioactive components and antimicrobial effects on food are well documented. According to Evbuomwan, et al., (2018), Vernonia amygdalina serves as vegetables and is used the preparation of food nutritive seasoning used in the preparation of food. Apart from its nutritive value, it has been found to be potential in inhibiting the growth of microorganisms.

2.1.5.3 Rosemary

Rosemary (Rosmarinus officinalis L.) is a shrub very popular in Europe, because it is used as a herb for its pleasant flavor and aroma. This aroma is due to the presence of essential oils that represent between 1 and 3% of the total

mass of leaves and flowers. The oil consists mainly of 1,8-cineol, α-pinene and camphor (Santos-Sánchez et al., 2017).

Rosemary has antioxidant activity due to the phenolic compounds found mainly in flowers. Among the phenolic compounds found in rosemary are carnosol, carnosic acid and rosmarinic acid. The rosemary extract has been approved as a food additive for use in the European Union since 2008 and is formally labeled

"Extracts of Rosemary E392". The European Union Regulatory Commission no. 231/2012 notes that carnosol and carnosic acid are the reference antioxidant compounds in rosemary extracts and the sum of these should not be less than 90% of the total phenolic diterpenes in the extract (de Raadt et al., 2015). Rosemary extracts also contain flavonoids with structures of luteolin and apigenin. Rosemary extracts are used as an additive to preserve meat, fish and oils (de Raadt et al., 2015).

A study of rosemary extract supplementation at carnoside acid and carnosol concentrations of 200 and 400 $mg \cdot kg^{-1}$ were also carried out on lambs during the fattening stage (Ortuño et al., 2014). The results of this study showed that the half-life of the meat obtained from the lambs was prolonged.

A study carried out by Jordán et al. (2014) showed that the presence of carnosol in rosemary extracts is important for improving the oxidative stability of carnosic acid during the processing of sheep's tissue, enhancing the antioxidant

activity of the rosemary extract. This shows that combining phenolic compounds with a similar chemical structure produces a synergistic effect in terms of their antioxidant activity. Jensen et al. (2011) evaluated the sensory properties of rosemary extracts in the preparation of bread, and their results showed that the extract did not induce changes in the flavour and aroma of the product.

2.1.5.4 Ginger

Ginger (Zingiber officinale Rosc.) belongs to the Zingiberaceae family and is native to South-East Asia. Ginger is used in many countries as a spice and condiment to give a pungent taste to food (Park & Pizzuto, 2002). Ginger rhizome has also been used in traditional medicine, because of its diversity in terms of phytochemicals (Shukla & Singh, 2007). Jolad et al. (2004) grouped the phytochemicals of fresh ginger into volatiles and non-volatiles. Volatile compounds include sesquiterpenes and monoterpenoid hydrocarbons, which produce the aroma and flavor characteristics of ginger. Non-volatile compounds include gingerols, shogaols, paradols and zingerones, which give ginger its pungent taste. These non-volatiles compounds are free radical scavengers.

Ginger and its phenolic compounds are dual inhibitors of arachidonic acid metabolism. This means that phenolic compounds inhibit both cyclooxygenase and lipoxygenase, enzymes involved in the biosynthetic pathway of prostaglandin and leukotriene (Moghaddasi & Kashani, 2012). Müller et al.

(2006) showed that ginger is more effective than indomethacin in reducing pain associated with inflammation and oxidative stress. In addition, ginger may decrease muscle pain caused by strenuous exercise (Black et al., 2010).

Simon-Brown et al. (2016) developed a method of microencapsulation for ginger extracts using spray-drying technology. This allowed significant quantities of phenolic compounds to be retained in powders. Phenolic compounds in microencapsulated ginger can be incorporated quickly into products such as tea and bread. On the other hand, Kisnk and Elsheshetawy (2013) used ginger powder as an additive in mayonnaise and the sensory attributes enhanced as a function of the ginger at concentrations of 1.0 and 1.25%.

2.1.5.5 Turmeric

Turmeric (Curcuma longa) is a plant with very branched rhizomes adapted to warm humid areas. The rhizomes of the plant are yellow and are used as a yellow dye and as a spice. Its spicy taste and golden color improves the quality of the food. Turmeric is also the main ingredient in curry powders, and has been used to accentuate the flavor of pepper. India is one of the largest producers of turmeric (Santos-Sánchez et al., 2017).

Turmeric is considered safe in amounts that are commonly used in food. The FDA declared this food a GRAS, which means that it is generally recognized as safe to use as a food additive. It is a versatile spice that helps detoxify the liver,

balance cholesterol levels, fight allergies, stimulate digestion and increased immunity (Chainani, 2003). This plant contains the phenolic compound curcumin (diferuloylmethane).

Curcumin has antioxidant, anticancer, antidiabetic, antiproliferative and antiangiogenic activity (Strimpakos & Sharma, 2008). The other two phenolic compounds abundant in turmeric are demethoxycurcumin and bisdemethoxycurcumin. Curcumin provides turmeric with its yellow color and is now recognized as the compound responsible for most of its therapeutic effects. It is estimated that 2–5% of turmeric is curcumin. Curcuminoids decrease lipid peroxidation through conserving the activity of the antioxidant enzymes superoxide dismutase, catalase and glutathione peroxidase at high levels. The antioxidant properties of turmeric extracts are mainly due to diacetylcurcumin, demethoxycurcumin and bisdemethoxycurcumin (Faizal et al., 2009).

Curcumin has anticancer activity due to its effect on a variety of biological pathways involved in the mutagenesis, oncogene expression, cell cycle regulation, apoptosis, tumorigenesis, and metastasis (Wilken et al., 2011). Curcumin has an antiproliferative effect on various cancers and is an inhibitor of the NF-B transcription factor. Turmeric powder (Curcuma longa) was used in a fried rice snack, yukwa, at different concentrations.

The textural properties of yukwa were not changed until the turmeric powder

content reached 5%; however, an addition of over 8% induced a decrease in hardness and an increase in crispiness. Based on the sensory characteristics, a 5% addition of turmeric powder was the most acceptable for the yukwa product (Seugn-Taik & Han, 2016).

2.1.5.6 Chilli pepper

Chilli pepper is one of the spices most consumed in the world and usually is used as a food additive (Bown, 2001). This fruit is part of the traditional medicine of India, Mexico and China, and is used for the treatment of arthritis, rheumatism and upset stomach (Van Wyk & Wink, 2004). These applications are related to capsaicinoids, phenolic compounds representative of the Capsicum genus (Zimmer et al., 2012), as well as to flavonoids and phenylpropanoids (Materska, 2014). The capsaicinoids are N-vanillylamides derived from fatty acids with 9–11 carbons, and the compounds most abundant are capsaicin (8-methylnontrans-6-enoic acid vanillylamide) and dihydrocapsaicin (8-methylnonanoic acid vanillylamide).

The sum of both compounds occurs in the chilli fruit in quantities greater than 80% with respect to the total capsaicins (Topuz & Özdemir, 2007). The capsaicinoid concentration varies significantly from cultivar to cultivar. Wahyuni et al. (2011) studied 32 different cultivars of Capsicum and found that the cultivar of C. frutescens Lombok (No. 28) contained the highest concentrations of capsaicinoids in the pericarp, with levels of capsaicin and

dihydrocapsaicin of 60 and 15 mg × (100 g of fresh weight)-1, respectively.

Conforti et al. (2007) evaluated the antioxidant activity of the methanol extract of the hot pepper fruit (C. annuum L. var. acuminatum) at three stages of maturation (small green, green and red), the free radical scavenging activity was measured using 2,2-diphenyl- -1-picrylhydrazyl radical (DPPH•) assay, bovine brain peroxidation assay and β-carotene bleaching test. The variation in lipophilic and phenol compounds shown in the three stages of maturation of the fruits of C. annuum generated differences in antioxidant activity.

The green pepper extracts showed significant activity to avoid lipid peroxidation, with the subsequent inhibiting the formation of malondialdehyde (MDA), while the small green pepper showed greater free radical scavenging activity.

On the other hand, it should be noted that in addition to the capsaicins, phenylpropanoids and flavonoids have also been identified in chilli fruit. Materska (2014) carried out a study to identify phenolic compounds in the fruits of sweet (Red Knight, Shanghai and Socrates varieties) and semi-spicy (Capel Hot variety) chillis. The flavonoids identified in these cultivars were glycosides of flavonoids derived from quercetin, luteolin, and apigenin.

The chilli pepper has been used to prevent degradative processes of oils and fruits; for example, Martínez-Tomé et al. (2011) showed C. annuum extracts are capable of inducing significant oxidative stability in refined olive oil tested

using the Rancimat method. On the other hand, Ponce et al. (2008) used a chitosan coating enriched with chilli oleoresin for the antioxidant protection of minimally processed butternut squash, inducing the prevention of browning reactions.

2.1.5.7 African black pepper

P. guineense commonly referred to as African black pepper or Ashanti pepper belongs to the family Pipera-ceae. It is known with different vernacular names in Nigeria which include ‘Uziza’ in Igbo, and ‘Iyere’ in Yoruba. P. guineense has culinary, medicinal, cosmetic and insectcidal uses (Okwute, 2012). The leaves are considered aperitive, carminative and eupeptic. They are also used for the treatment of cough and bronchitis, (Martins et al., 2018) intestinal diseases and rheumatism (Sumathykutty et al., 2009; Saganuwana, 2009; Ogbole et al., 2010). The seeds and leaves are used as spices in various African dishes. It has also been used as an insect repellant (Adewoyin et al., 2006). The plant is utilized in different forms, such as whole herbs, powders, extracts and vapours, for a variety of purposes (Martins et al., 2008).

2.1.5.8 Neem plant

Neem (*A. indica*) is a tree of the Meliaceae family coming from the Indian subcontinent and actually present worldwide. Neem importance and distribution is increasing all over the world, due to its beneficial properties, as reported by (Nicoletti, et al., 2013). Neem is considered an effective source of

environmentally-powerful natural pesticide and considered to be one of the most promising pesticides. It is believed to be one of the trees of the 21st century for its great potential in pest management, environmental protection and medicine (National Research Council, 2012).

The ability of Neem leaf powder to decrease the decay level of tomatoes is an indication that Neem leaf powder can serve as a possible alternative in the prevention of tomato decay by pathogens. Raheja and Thakore (2012) reported that extract from medicinal plants like Allum sativum (cloves), Azadirachta indica (leaves), Mentha arvensis (leaves) and Psoralea Corylifolia were found most effective in preserving plant fruits from attack by pathogenic and environmental factors. The ability of Neem leaf powder to minimize the decay of tomato fruits in their study can be attributed to the fact that the Neem leaf powder suppressed the activity of certain fungi that cause spoilage of tomato fruits. According to Hosea, et al., (2017) study, treating tomato fruits with Neem leaf powder significantly increased their shelf life in the number of days it took for complete spoilage of the fruits to occur. In another study, Ejale and Abdullah (2004), treating tomato fruits with Neem significantly increased their shelf life. Irokanulo et al. (2015) also noted that tomato fruits treated with the powders of Moringa oleifera plant parts had an extended storage life. A study by Serrone et al., (2015) revealed the use of neem oil as a natural preservative that can control meat spoilage.

2.1.5.9 Moringa oleifera (Mo)

Moringa oleifera (Mo), an aboriginal of Indian subcontinent, is a member of the Moringaceae family of perennial angiosperm plants, which includes 13 other species (Farooq, Walid, Kobayashi, Fujita & Basra, 2012). India being the largest producer of Moringa, has an annual production of between 1.1 to 1.3 million tonnes of tender fruits from an area of 380 km² (Rajangam et.al., 2011). Moringa has the potential to improve nutrition, food security, among others. Aqueous, ethanolic and methanolic Moringa leaves extracts revealed broad antimicrobial potential. These extracts inhibited the growth of eight pathogenic bacteria and fungi species (Streptococcus pyogenes, Streptococcus agalactiae, Staphylococcus epidermis, Staphylococcus aureus, Salmonella senftenberg, Escherichia coli, Bacillus subtilis, and Candida albicans). This inhibition suggests that pharmaceutical and food industries can use Moringa leaves extracts as a natural antimicrobial (El Sohaimy et al. 2015).

Moringa leaves and seeds have been reported to contain antibacterial properties, acting against Gram-positive and Gram-negative bacteria (Saadabi & Zaid 2011, Rahman et al. 2009). The plant leaves contain pterigospermin, a compound that easily dissociates into two benzyl-isothiocyanate molecules, which has antibacterial and antifungal effects (Jayawardana et al. 2015). The presence of many phytochemicals in Moringa seeds can explain its antimicrobial activity, but, as well as in the leaves, benzyl-isothiocyanate is

remarkable. This compound can act directly on microorganisms, interrupting the cell membrane synthesis or inhibiting essential enzyme synthesis, disrupting microorganisms' growth (Bukar et al. 2010).

Moringa leaves and seeds extracts, obtained through percolation with the solvents ethanol and chloroform (1:10 w/v), showed sanitizers and preservatives properties. These extracts contain substances that act as antimicrobial agents against bacteria and fungi that are frequently associated with food spoilage and food contamination (Bukar et al. 2010). The extracts analyzed can be potential substitutes for artificial preservatives, satisfying the emerging consumers' interest, who have shown a change in nutritional habits with a preference for natural additives (Carocho et al. 2014).

One product that can be challenging for the food market is raw sugarcane juice, as it deteriorates shortly after extraction. To extend the validity of the product, manufacturers often use chemical preservatives. To offer other alternatives for this problem, Ramachandran et al. 2017 studied the effectiveness of combining different natural preservatives (Moringa leaf and seed extract, lemon, and ginger) at low temperature (2.0 °C). The authors found that the combination of Moringa seed extract and lemon at 10% v/v promoted a satisfactory antimicrobial effect, with a minimum inhibitory concentration (MIC) of 25 μL/mL against 15 bacterial strains. This combination promoted the highest acceptance among all samples, and was more effective against bacterial growth

than sodium benzoate (0.1%) and sodium metabisulfite (0.5%), chemical preservatives used as standard at its maximum allowed concentration.

To gather information on the Moringa application as a natural food additive in livestock products, Singh et al. 2015 described works carried out with the plant in a review article. The authors indicated that the dietary supplementation of goats, pigs, and broiler birds with Moringa leaves improves attributes such as meat color, odor, and lipid profile. It also improves the chemical composition and oxidative stability, without causing adverse effects on carcass characteristics (Singh et al. 2015).

The same work describes that Moringa leaf powder applied in meat products improved safety during the storage, reducing microbial counts. It also improved its nutritional value, ameliorated its physicochemical, sensory quality, and microbiological characteristics, and reduced the production cost (Singh et al. 2015).

2.1.5.10 Lemon grass

Lemongrass is a tropical perennial plant which yields aromatic oil. The name lemongrass is derived from the typical lemon-like odour of the essential oil present in the shoot. Lemongrass and clove extracts are considered to be better antibrowning agents than other volatile or essential oil extracts, in controlling enzymatic browning reactions. Treatments with squash and pepper extracts can

prevent browning and color changes in apple juices because they contain the sulfhydryl groups, phenolic compounds, organic acids and ascorbic acid (Roshita et al., 2014; İyidoğan and Bayindirh, 2014). Spices and 4-hexylresorcinol as antibrowning agents were also effective in tomato juice (Eissa et al., 2003).

Upon steam distillation of dried leaves, a yellowish-colored, strongly fragrant liquid called lemongrass oil is obtained, which has properties attributed to its strong chemical composition. The active ingredients present in lemongrass essential oil are myrcene, limonene, citral, geraniol, citronellol, geranyl acetate, neral, and nerol. Although myrcene and limonene are aromatic compounds, citral and geraniol serve as an antimicrobial and insecticidal, respectively. This oil counteracts fungi, bacteria, and also insects in general. Additionally, lemongrass oil is a natural food preservative. Recent studies suggest that the use of pure lemongrass essential oil is an innovative and useful tool as alternative to the use of synthetic fungicides or other sanitation techniques in storage and packaging. Its use as an alternative food preservative and the effectiveness of the essential oil depends on the target pathogen (Aluyor & Oboh, 2014).

2.1.6 Concept of Indigenous Plants

Indigenous or native plants are those plants that originated in a given geographic area without human involvement or that arrived there without intentional or unintentional intervention of humans from an area in which they

originally originated. By contrast, non-native plants (also called alien, exotic, or non-indigenous plants) owe their presence in a given geographic area to intentional or unintentional human involvement."

A native plant is one that occurs naturally in a particular habitat, ecosystem, or region and its territories or possessions, without direct or indirect human actions (The American Gardener, 2008). "Native plants can also be defined as those that have evolved and adapted to a specific location and have remained genetically unaltered by humans. This definition takes into account time and place, as well as the human element. More importantly, it implies a connection between generations through a shared evolutionary ancestry. Medical plant can be indigenous plant.

A medicinal plant is any plant which, in one or more of its organs, contains substances that can be used for therapeutic purposes or which are precursors for the synthesis of useful drugs. This description makes it possible to distinguish between medicinal plants whose therapeutic properties and constituents have been established scientifically, and plants that are regarded as medicinal but which have not yet been subjected to a thorough scientific study.

A number of plants have been used in traditional medicine for many years. Some do seem to work although there may not be sufficient scientific data (double-blind trials, for example) to confirm their efficacy. Such plants should qualify as medicinal plants. The term 'crude drugs of natural or biological

origin' is used by pharmacists and pharmacologists to describe whole plants or parts of plants which have medicinal properties. A definition of medicinal plants should include the following (Sofowora 2008; Evans, 2008):

(a) plants or plant parts used medicinally in galenical preparations (e.g. decoctions, infusions, and so on.) e.g. Cascara bark;

(b) plants used for extraction of pure substances either for direct medicinal use or for the hemi-synthesis of medicinal compounds (e.g. hemi-synthesis of sex hormones from diosgenin obtained from Dioscorea yams);

(c) food, spice, and perfumery plants used medicinally, e.g. ginger;

(d) microscopic plants, e.g. fungi, actinomycetes, used for isolation of drugs, especially antibiotics. Examples are ergot (Claviceps purpurea growing on rye) or Streptomyces griseus.

2.1.6.1 Efficacy of Plant Antimicrobials as Preservative in Food

Food preservation is dominant features in all food sectors and mainly comprises curbing the rise of microorganisms that increase the health-related issues in consumers (da Silva Dannenberg et al., 2016). The food attributes that attract the attention of the consumer are freshness and their naturalness and minimal processing. The perception of naturalness drives the consumer towards the food without chemical preservatives (Pasha et al., 2014). Modernization coupled with the change in the life style of the consumer shifts them towards the use of ready-to-use food. Thermal processing, drying, freezing, refrigeration,

irradiation, modified atmosphere packaging (MAP) and addition of antimicrobial agents or salts are some conventional methods to prevent the growth of microbes in foods (Aneja et al., 2014).

Thermal processing is commonly applied in food industry to inactivate the microorganisms and enhance shelf life of food. However, pasteurisation reduces the level of some bioactive compounds such as anthocyanin pigment, carotenoids and vitamin c that has been reported in several fruits. Emerging nonthermal technology like high hydrostatic pressure (HHP), ultraviolet, ozone processing, pulsed electric fields and ultrasound has promising role in maintaining the nutritional and sensory quality of food. Dense phase carbon dioxide (DPCD) technique is generally employed for liquid foods. Pressure used in DPCD damages the tissues of the fruits (Aneja et al, 2016).

The high intensity and longer duration time used in PEF affect the nutritional quality of foods. High dosage of ozone processing used for decontaminating food surface alters the sensory quality of the food. Nonetheless, the main limitation of applying UV-C light in food is its penetration, so it is only effective for the surface decontamination of food (Zhang et al., 2015).

Besides, these some chemical preservatives such as sodium benzoate, potassium sorbate and nitrites have been used commercially in fruit juices, dairy products, confectionary, meat and meat products, and so on. Nitrites and nitrates are applied in meat industry to inhibit the growth of the microorganisms, retain the

red colour of the meat and reduce the oxidation of lipid. However, blue baby syndrome occurs in children owing to the presence of high amount of nitrites in their blood (Gassara et al., 2016). Some chemical preservatives such as sodium benzoate and potassium sorbate used in fruit juice industry have also constraints like benzoic acid that is converted into benzene in foods, and S. cerevisiae and Pichia anomala are able to decarboxylate sorbic acid to 1,3 pentadiene which cause kerosene-like off-odour. Schizosaccharomyces pombe may produce off-flavours in the presence of sulphite. Due to growing evidences about the harmful effects of chemical preservatives, there is continuous pressure to reduce the amount of added preservative in foods (Tserennadmid et al., 2011).

To avoid the health risks associated with the consumption of foods, natural antimicrobial compounds like bacteriocins, chitosan-fermented ingredients and plant antimicrobials provide another alternative for preserving food. Spices and herbs are used in food since the ancient time not for flavouring but also for the preservation. Plant extracts, essential oil and peptides exhibit a broad-spectrum activity. The antimicrobial and antioxidant properties of plants are attributed to secondary metabolites such as phenylpropanoids, terpenes, flavonoids and anthocyanins (Tajkarimi et al., 2010]. Several studies have been conducted around the globe to prove the efficacy of plant products, and various compounds isolated from these plants are secondary metabolites which possess antimicrobial and medicinal properties (Raybaudi-Massilia et al., 2009; Ota &

Ulrih, 2017).

2.1.6.2 Antimicrobial from plants

To circumvent the losses due to food-borne outbreaks, an effective method of preservation should be adopted in food factories and restaurant for controlling food-borne outbreaks. Application of antimicrobials in foods retards the growth of spoilage microorganisms and prevents the growth of pathogenic microorganisms. Natural antimicrobial compounds are obtained from plant, animal and microbes. Lactoferrin, lactoperoxidase and lysozyme are naturally occurring antimicrobials in animals. Bacteriocins like nisin and pediocin are bio preservative from microbial origin used commercially in food. Several forms of plant products such as essential oil, plant extract either in pure or crude form and plant antimicrobial peptide have also potential to utilise as a biopreservative in food (Aneja et al., 2016).

2.1.6.3 Plant extracts

Spices and herb are used as flavouring agents as well as a preservative since the ancient time. Plant parts are used as spice like leaves (mint, rosemary), flower (clove), bulb (garlic, onion) and fruit (cumin, red chilli). They enjoy the status of GRAS (De La Torre Torres et al., 2017). Factors that affect the antimicrobial efficacy of a compound incorporate target microorganism, initial microflora of the food and environmental factors. The chemical nature of the phytochemicals

determines its activity against microorganisms. Plant extracts are widely used in the food industry, and antimicrobial nature of the plant extract is influenced by its phytochemicals (Chouhan et al, 2017). Phenolics, phenolic acids, quinones, saponins, flavonoids, tannins, coumarins, terpenoids and alkaloids are the major classes of chemical constituents that influence the antimicrobial and antioxidant activity as well as flavours of the plant. The hydroxyl group of the phenolic compounds imparts its antimicrobial activity. OH group interferes with the function of the cell membrane and shifts the electrons that act as proton exchangers, disintegrates proton-motive force, inhibits ATP synthesis and causes cell death (Gyawali & Ibrahim, 2014).

Clove exhibits antibacterial activity against Escherichia coli, Listeria monocytogenes, Salmonella enterica, Campylobacter jejuni and Staphylococcus aureus and antifungal activity against Candida albicans and Trichophyton mentagrophytes (Chaieb et al., 2017; Tampieri et al, 2015). The antimicrobial activity of the clove is owing to the presence of eugenol (Tajkarimi et al., 2010). Cinnamaldehyde, cinnamyl alcohol and eugenol confer the antimicrobial activity of cinnamon. Cinnamaldehyde exerts its action on bacteria via inhibiting their cell wall synthesis, impairing cell membrane function and affecting the synthesis of nucleic acids (Winias, 2015). Phenolic compounds of black pepper damage the bacterial membrane and affect the antimicrobial activity. In addition to antibacterial activity, antifungal activity of black pepper

was also observed against the Fusarium graminearum and Penicillium viridicatum (Singh et al., 2004). Carnosic acid and phenolic compounds influence the antimicrobial and antioxidant activity of rosemary plant (Almela et al., 2006). Polyphenolic compounds such as 6-gingerol present in ginger confer the antimicrobial and antioxidant activity of the ginger (Stoilova et al., 2007). Carbazole alkaloids and coumarins influence the antimicrobial activity of curry leaves (Murugan et al., 2013). Raisin extract in wheat at a concentration of 7.5% is effective for control of spoilage mould and enhances the shelf life of bread; however, this result does not significantly differ from the positive control (0.24% propionate) (Wei et al., 2009).

The plants that possess antioxidant property which belong to Lamiaceae, rosemary, oregano, thyme, sage, marjoram, basil, coriander and pimento are predominant (De La Torre Torres et al., 2017). Lipid peroxidation is the main culprit in the rejection of meat and meat products. Antioxidant compound decreases the lipid peroxidation. Plant extract comprises antioxidant activity attributed to their phenolic component. Selection of solvent is an important tool for the extraction of antioxidant property of the plant.

Several studies support the antioxidant activity of plants in meat. The antioxidant activity of grape seed extract in pork patties stored at −18°C for 6 months was higher than that of oregano extract, oleoresin rosemary, butylated hydroxyanisole and butylated hydroxytoluene (Sasse et al., 2009). Similar

results of antioxidant activity of grape seed extract were observed in beef patties, and the freshness and sensory quality of the product were retained for 4 months at −18°C and 6 months at the same temperature and in frankfurters [92], restructured mutton slices at refrigeration temperature (Kulkarni et al., 2011; Reddy et al., 2013, Özvural et al., 2012). The 0.1% of clove essential oil had higher antioxidant activity in buffalo patties at 8°C for 9 days in comparison to grape seed extract (Tajik, Farhangfar, Moradi & Razavi, 2014).

2.1.6.4 Hurdles in plant antimicrobials as preservative in foods

Plant antimicrobial compounds have an efficacy as preservative and food ingredients. Before October 1994, food additives from plant sources are used without any regulatory test. Currently the trend has moved towards the rapid expansion of utilisation of plant antimicrobials as additive, ingredient or supplement in several health food products (Prakash et al., 2018). The United States Food Drug Administration and European commission approved some essential oil as food preservative. The main barrier encountered in the use of essential oil in food is the inability of the reproducibility of their activity. Although they contain diverse nature of the chemical compounds, they have different qualitative their biological effectiveness (Perricone et al., 2015). The other major obstacle that limits the use of essential oil in food is their strong aroma that alters the organoleptic property of food. Beside that the nature of the food also affects the efficacy of essential oil in food. Food is comprised of

different microenvironments; hence, the concentration of essential oil is also increased that leverage the taste of the food resulting in the rejection of food (Negi, 2012). Strong aroma flavour of essential oil is minimised by meticulously choosing the essential oil according to the type of food. Availability of raw material and risk of the loss of biodiversity also hinder the use of plant essential oil as preservative (Li et al, 2011; Prakash et al, 2018).

The in vitro antimicrobial activity of plants has been demonstrated in several studies. However, hardly an antimicrobial study of plant extract has been available in food. In most of the studies, the results of in vitro antimicrobial activity of plant extract differ from the antimicrobial activity observed in food. The low activity of the plant in food is attributed to involvement of crude extract in most cases, and they possess low activity in contrast to pure compounds. Crude extract which comprises of flavonoids in glycosidic form retards their effectiveness against the microorganism. The presence of extracting solvent also creates a hurdle for the use of plant extracts in food (Negi, 2012). The application of antimicrobial peptides derived from plants in food is at its infancy stage. Lots of work have to be done to prove its potential as preservative in food.

2.2 Theoretical Framework

2.2.1 Health Belief Model

The Health Belief Model (HBM) was propounded in the 1950 by American Psychologists - Godfrey Hochbaum, Irwin Rosentock and Stephen Regels to explain the widespread facture of tuberculosis screening (Glanz, Rimer, & Lewis, 2002). The model provides a tool for identifying clients perception of disease and the decision making process the person uses in seeking health services. The HBM assumes that individuals take precautionary measures (risk reduction) when they perceive themselves susceptible to a disease or condition, acknowledge consequences of a condition as severe, accept that taking precautionary measures will be beneficial in reducing risk, and that benefits of taking action will overcome perceived barriers (Melkote & Steeves, 2001). According to Maiman and Becker (1974), the basic components of the HBM are derived from a well-established body of psychological and behavioral theories whose models hypothesize that behaviors depend mainly upon two variables: the value placed by the individual on a particular goal and the individual's estimate of the goal. When these variables are understood in health terms, the outcomes are seen as:

1. The desire to avoid illness or to get well if ill
2. The belief that a particular health action will prevent or reduce illness.

The basic components of HMB include: perceived susceptibility,

perceived seriousness, benefits, perceived barrier, cues to action and self efficacy.

- ***Perceived susceptibility***: reflects person's belief about likelihood of getting a disease condition. The greater a person's perceived risk, the greater the likelihood of the person engaging in behaviour to lessen the risk.
- ***Perceived severity***: also reflects a person belief about the serious consequences of a disease.
- ***Perceived benefits:*** also reflect a person belief that a certain action will reduce risk or the seriousness of an impact.
- ***Perceived barriers:*** reflect a person's evaluation of obstacles in her way that prevent her from adopting a new behavior. These concepts were proposed as accounting for people "readiness to act".
- ***Cue to action :*** cue to action would activate that readiness and stimulate overt behaviour. It is the cues to action that starts the whole process of change.

Application of Health belief Model

The theory of health belief model is applied to the study of perception, knowledge and utilization of indigenous plants for food preservation among farmers.

Perceived susceptibility: There are numbers of factors that can influence a people's decision, example; cultural factor can hinder adoption of non-conventional methods.

Perceived barrier: The perceived susceptibility and perceive severity will

combine to determine the perceived barrier of an illness or problem.

Perceived benefits: Adoption of indigenous plants will be enhanced when the farmers perceive the benefit of indigenous plants e.g herbs and spices for disease control, and so on.

Likelihood of Action: The likelihood of a person taking recommended preventive health action depend on perceived benefits of action outweigh their perceived barrier to the action. The likelihood that a farmer would utilize indigenous plants has benefits, that the utilization has benefits that protect them from effects of usage of synthetic preservatives.

In this study, the desire to utilize indigenous plants in food preservation will depend on the value the indigenes/residents place on the health benefits as well as their estimation of the goal of achieving good health for them and their children. The values placed on the available options often evolve from long term experiences and socialization process. Farmers with poor knowledge and perception of indigenous plants for food preservation will place lower values on the use of indigenous plants for food preservation and vice versa.

2.2.2 Theory of Planned behaviour

Theory of planned behaviour was propounded by Ajzen in 1985. This theory takes a look at the issue of health behaviour from intention-modifiers. These modifiers were grouped into attitude toward the behaviour, subjective social norm and perceived behaviour in terms of personal motivations and the social context of the actor. It suggests that any study aimed at understanding health

behaviour should begin with an understanding of the specific cultural elements influencing people's beliefs and practices toward the health behaviour.

Studies that have examined the relevance of the theory of planned behaviour to health related issues are beginning to emerge. The theory has been successfully applied to other health-related issues such as losing weight, exercising, behaviour of colorectal cancer, smoking cigarettes and mothers' intention to use oral rehydration therapy (Hounsa, Dodin, Valiois, & Garard, 2003).

The theory takes intention as a construct representing one's motivation towards adoption of behaviour with the development of personal motivation being seen as the first step towards the adoption of any social behaviour. The theory has three constructs. These are attitude towards behaviour; perceived social norm regarding the adoption of this social behaviour and perceived behaviour control over the adoption of this behaviour. Ajzen and Madden (1986) derived a model from this theory.

Applying this to the study of utilizing medicinal plants, attitude towards its utilization is expressed by one's positive or negative evaluation of its efficacy. That is, using it to prevent food spoilage is evaluated as good or bad. The second component termed subjective norm as conceptualized in this study holds that the desire to use medicinal plant depends on the social norms about such response and reaction of the significant other such as the head of the household. The third component which is the perceived behavioural control was defined by

Ajzen and Madden (1986) as the perceived presence or required resources and opportunities as well as anticipated impediments and obstacles. For example, the impediments of accessing medicinal plants.

However, this theory has been criticized on the grounds that it does not embody all dimensions that could affect personal motivation towards adoption of a given behaviour. What this theory does is that, it predicts the intention to adopt certain health behaviour and not necessarily the adoption of the behaviour. There are many intervening variables between intention and action.

2.3 Empirical Studies

Otinwa, Onwuama, Owolabi and Idris (2015) conducted a study on Knowledge and Behaviour of Consumers towards Food Additives in Lagos State. Descriptive research method was adopted for the study. The study population comprised secondary school teachers and young adults in tertiary institutions in Lagos State, Nigeria. Stratified sampling technique was used to select two hundred and fifty participants. Food Additive Utilisation Questionnaire (FAUQ) was used for data collection. Data was analysed using the descriptive statistics of percentages, mean, standard deviation and the inferential statistics of Multiple Regression analysis at 0.05 alpha level. The findings revealed that knowledge of health implications and behaviour of consumers towards food additives significantly influenced consumption of products by consumers. It was recommended that health education should be reinforced as means of reducing

the detrimental effect of consumption of foods and drinks with additives. There is also need for regulations concerning the sale of food additives should be modified to require the reporting of adverse effects boldly to the consumer to strictly adhere to positive behaviours towards food additives.

Rahman, Fardusi and Reza (2011) conducted a study on traditional knowledge and use of medicinal plants by the Patra tribe community in the North-Eastern Region of Bangladesh. This was an exploratory study. A total of 33 households were assessed using different participatory appraisals through direct observation and semi-structured questionnaire. A total of 31 medicinal plant species belonging to 23 families were recorded with the help of tribal people of the area as mostly collected from the forest and were found to use for curing 55 ailments; ranging from simple headaches to highly complicated eye and heart diseases, including diabetes, jaundice, chickenpox, dysentery, constipation, teeth ache, cut and wounds, diarrhea and so on. Study also revealed that majority of the species used by the local inhabitants was herbs (6 species) followed by trees (14 species), shrubs (8 species), and climbers (3 species). For curing ailments, the use of aboveground plant parts was higher (76%) than the underground plant parts (17%) among mainly used leaves, either taken orally or used externally. Homesteads (32%) are the primary source followed by forest (27%) and few medicinal plants are cultivated. Since this knowledge is handed down orally from generation to generation, there is a great possibility that the

knowledge will be lost over time. The findings of the study conclude that the conservation of the indigenous knowledge of the Patra tribe regarding medicinal plants can help conserve the forest.

Rahman, Biswas, Barman and Ferdous (2016) conducted a study plant extract as selective pesticide for integrated pest management. The over use of chemical pesticides causes environmental and health problem have been the matter of concern so plant extracts which known as biocide or green pesticides can be an alternative good source of chemical pesticide due to their safe, eco-friendly and more compatible properties. These are being used to manage the pest and minimize the yield loss. The different types of plant extract used as biocides such as neem, garlic, tobacco, kappettiya, syringe, ginger and many others are being utilized to control and manage the pest or disease of different plants. The petroleum ether extract of periwinkle, can be used to control the pest Uzi fly during sericulture. The neem extract of different concentrations show significant effect to control pest of rice, betel leaf and vegetable. Garlic bulb extract, tobacco and kappettiya leaf extract, Eve's apple latex/ fruit/ seeds extract, lilac flower extract, neem leaf/ seeds or it oil all are act as potential insecticide to tea, rice, betel leaf and vegetables pest.

Onyango et al. (2014) conducted a study on identifying and collecting herbal plants commonly used in milk processing and preservation by the Maasai community in Kajiado district and to determine the phytochemical and mineral

composition. Twenty-three herbal plants were identified; three plants were selected through community prioritization using a structured questionnaire. Analysis for phytochemical composition was done using Harborne (2008) methods composition by AOAC method 923.03 and pH. Tannins, saponins, flavonoids, alkaloids, steroids, sterols, terpenoids, flavones aglycones and reducing compounds were present in all the herbal plants. The herbal plants were significantly different ($P<0.05$) in mineral content. The highest mineral content was calcium 90.0 mg/100 g followed by magnesium, zinc and iron. This indicates that these plants are rich in phytochemicals and minerals therefore, they can be exploited to develop nutritive food preservatives because phytochemicals have both antimicrobial and antioxidant properties. These plants can also be processed to obtain a product that will substitute the chemical preservatives in the market now that consumers are showing greater preference for products preserved with natural products.

Olanipekun and Agbadaola (2013) conducted a study on ethnobotanical studies of plants used for preservation of plant products in Ikere Ekiti, Ekiti State, Nigeria. The study employed survey design. The study was carried out by interviewing the respondents using a well-structured, open-ended questionnaire and guided techniques. A total number of 25 species belonging to 18 families were collected and identified. There were more female respondents (64%) than male (36%). The respondents' indigenous technical knowledge revealed that

most of the botanicals were single-components preparation while few involved the combination of more than one plants in a single usage. Identified samples of the plant species used for preservation of plant produce were collected; their sources and method of application were defined. In addition, the folk medicinal values of the plants were also documented. Voucher specimens were deposited at the herbarium of Plant Science Department of Ekiti State University. However, some plants were found to be endangered, thus, strategies that could help in conserving them were proposed.

Asogwa and Okoye and Oni (2017) conducted a study on promotion of indigenous food preservation and processing knowledge and the challenge of food security in Africa. Nearly 240 million people in sub-Saharan Africa lack adequate food for a healthy and active life. There is therefore an urgent need to look for more practical ways to tackle this challenge. One of such ways is the promotion and utilization of indigenous knowledge (IK) of food processing, preservation and storage. Africa is blessed with various types of food produce and also possesses diverse indigenous knowledge systems for their preservation and storage. Using of indigenous knowledge (IK) in solving food shortage therefore remains a powerful means of sustaining household food security. These indigenous methods of food preservation such as sun drying, fermentation, germination and soaking are time tested and has been used by locals over generation to preserve their produce after harvest thereby serving as

a survival strategy. Simple, low-cost, traditional food processing techniques are also the bedrock of small-scale food processing enterprises that are crucial to rural development in Africa. Traditional/indigenous foods also provide inexpensive, safe, nutritious foods throughout the whole year thus boosting overall food security. Traditionally, long-term methods like fermentation and drying have been used for fruits and vegetables. They also provide an economic means of preserving food thus making it available during the period of scarcity. Unfortunately, despite these benefits, IK is fast eroding. Factors enhancing this gradual destruction include influence of western culture, changing socio-cultural status of women, lack of documentation, high illiteracy level among women. This review recommends that there is an urgent need to preserve and promote IK as a very important resource. All stakeholders must therefore be involved - governmental, and non-governmental bodies as well as the local people themselves.

2.4 Summary of Reviewed Literature

The conceptual framework of the review deals with the explanation and definitions of concept of food seen as any substance solid or liquid material which when eaten and digested provides the body with the needed nourishment. However, safe and hygienic food is a requirement for a healthy society. The problem of food-borne outbreaks has built a challenge against the food and health regulatory authorities to control the pathogenic microorganisms.

Chemical preservative has created some health problems in foods, so the recent trend is towards the use of natural antimicrobials in foods. Plants are valuable source of bioactive molecules exhibiting antimicrobial activities. The plant antimicrobial compounds have diverse chemical nature such as alkaloids, phenolics, terpenes, terpenoids, flavonoids, essential oil, and so on.

The theoretical framework focused on two related theories. Health belief model theory that assumes that individuals take precautionary measures (risk reduction) when they perceive themselves susceptible to a disease or condition, acknowledge consequences of a condition as severe, accept that taking precautionary measures will be beneficial in reducing risk, and that benefits of taking action will overcome perceived barriers. Also, the theory of planned behaviour with its emphasis on takes intention as a construct representing one's motivation towards adoption of behaviour with the development of personal motivation being seen as the first step towards the adoption of any social behaviour.

The last part of the review dealt on some related empirical works. The reviewed works showed that there is few works on the knowledge and perception of the use medicinal plants as food preservatives. Morever, the review did not highlight on knowledge and perception of the use medicinal plants as food preservatives among farmers in Ivo LGA in Ebonyi State. It is on the basis of this revelation that the current study is initiated to fill the existing gap.

CHAPTER THREE

MATERIALS AND METHODS

In this chapter, the processes and procedures that were followed in carrying out the study were discussed under the following sub-headings:

3.1 Research Design

The research design adopted for this study was a Qualitative Descriptive Survey Design. Survey research design according to Izundu in Nkata (2006) involved assessing attitudes or opinions of respondents. The design was used to collect detailed factual information that described existing phenomena. It is interested in the accurate assessment of the characteristics of the whole population of people by studying samples, drawn from the population. It focuses on people, the vital facts of people, their beliefs, opinions, attitudes and motivation. It also interprets, synthesizes, and integrates data, and points to implications, and interrelationships.

Survey research design is also practical, as it identifies present condition, and points to present needs (Nworgu, 2006). The choice of the design was because it is concerned with people and focused on contact farmers, it found out the characteristics of a sample which will be used to generalize on the entire population pointing to implications and interrelationships.

3.2 Area of the Study

The study was carried out in Ivo LGA of Ebonyi State. It has its headquarters in

Isieke. The Local Government is bounded to the north by Nkanu east Local Government of Enugu State and Ohaozara Local Government Area and to the east by Afikpo south Local Government Area and to the east by Afikpo south Local Government Area and to the south and west by Abia State. Ivo L.G.A comprises four autonomous communities namely: Ishiagu, Ihe, Umuihe and Akaeze with Isiaka as administrative headquarter. It has an estimated population of about 141,980 as reported from 2006 Census. Their official language is English, local language is Igbo with minor differences in dialect. Christianity is the predominant religion, however, there are traditional worshippers. Popular festivals held in Ivo LGA include the Ikeji and the Isiechera masquerade festivals while important landmarks in the LGA include the Federal College of Agriculture Ishiagu and Crushed Rocks Industries Limited.

Ivo LGA has a rich agricultural heritage and known for the abundant production of a variety of crops such as yam, rice, maize, cocoyam and cassava. The main occupation of the people is farming. The area is also rich in mineral deposits such as limestone. Other important economic activities engaged in by the people of Ivo LGA include pottery and trade. The area is chosen is because the intensive farming experience of the people in the area on the potent uses of medicinal plants as food preservatives.

3.3 Population of the Study

The population of the study was one hundred and forty-one thousand, nine hundred and eighty (141,980) residents in Ivo LGA of Ebonyi State.

3.4.1 Determination of Sample size

A sample size for the study consisted three hundred and ninety-six (396)

farmers in Ivo LGA. The Taro Yamane method for sample size was used to determine the sample size for the study. Below is the mathematical illustration for the Taro Yamane:

$$n = \frac{N}{(1+N(e)^2)}$$

Where n signifies the sample size, N signifies the population under study

E signifies the margin error (it could be 0.10, 0.05 or 0.01)

N = 141,980, e = 0.05

$$n = \frac{141980}{(1+141980(0.05)^2)}$$

= 396

3.4.2 Sample and Sampling Technique

Multi-stage cluster sampling technique was employed to arrive at the sample size. Stage one involved the use of simple random sampling of balloting without replacement to select three autonomous communities out the four existing autonomous communities in the LGA. Stage two involved the use of disproportionate sampling to select three wards from each community, giving rise to nine (9) wards. Stage three involved the use of purposive sampling to select forty-four (44) farmers from each ward to arrive at 396 which was the sample size for the study.

3.5 Instrument for Data Collection

The instrument for data collection was a structured questionnaire. The questionnaire was divided into four (4) sections, sections A, B, C and D. Section A dwelt on demographic questions. Section B, C and D dwelt on

Knowledge, perception and utilization of indigenous plants for food preservation.

3.6 Validity of Instrument

To ensure validity, the questionnaire was passed to a research expert and supervisor for face and content validity and corrections.

3.7 Reliability of Instrument

The researcher employed a test re-test method to ascertain the reliability of the validated instrument for the study. Twenty (20) copies of the validated questionnaire were administered to farmers in Akaeze town a neighbouring town at an interval of two weeks. After two (2) weeks interval, the instrument were re-administered to the same respondents. The first score (x) and the second score (y) was correlated using Spearman's Rank order of Coefficient Correlation (rho) to achieve a reliability index score, to the degree of reliability of the instrument. An index score of 0.78 was considered reliable for the study. This is in line with Cohen, Manion and Moniscon (2011) who stated that a correlation coefficient (r) of .70 and above is considered high. Therefore, the reliability index of .78 implies high reliability since it falls within the range.

3.8 Method of Data Collection

Permission for the study were obtained from the farmer groups. The questionnaires were personally administered by the researcher to respondents by

hand and collected thereafter. The questionnaires were distributed on face to face basis. All three hundred and nine-six (396) copies of questionnaire distributed were correctly filled and returned on the spot to achieve 100% return rate.

3.9 Method of Data Analysis

Data obtained from the questionnaire were subjected to descriptive statistics of frequency, mean and standard deviation to answer the research questions while the hypotheses were tested using inferential statistics of ANOVA at 0.05 level of significance at appropriate degree of freedom. Analysis of data were done with the SPSS version 23.

3.10 Ethical Consideration/Informed Consent

A letter of introduction was collected from the Head of Department (HOD) to the leader of farmers in Ivo LGA for permission to study in their domain.

- Permission was obtained from the leaders of the farmers.
- Informed written consent was used to obtain good interpersonal relationship and rapport with the respondents.
- Confidentiality and anonymity regarding information obtained from respondents was maintained.
- The researcher was honest in recording and reporting findings. All literature materials were acknowledged.
- The right of the respondents were respected.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Characteristics of the Study Participants

There were in all 396 farmers that participated in the study, of which 213 (57.3%) were males and 169 (42.7%) were females. More than half of the participants were at least 35 years of age of which 115(29.0%) and 114 (28.8%) were respectively 45-54 years and above 54years, while 84 (21.2%) were between 35-44 years of age. Only 27 (6.8%) were within 15-24 years old.

In terms of education level attained, more than half (213: 53.8%) had secondary education level, up to 112 (28.3%) had primary school level and 57 (14.4%) had tertiary education level while 14 (3.5%) had no formal education.

Many of the participants have reasonable number of years of farming experience approximately 36% having at least 16 years farming. There were 142 (35.9%) with 6-10 years of farming experience, 84 (21.2%) have 1-5 years farming experience, 28 (7.2%) have 11-15 years of experience in farming. The clear majority of the study group were involved in commercial farming type (359: 72.1%), while 113 (28.5%) engage in subsistence farming

The income status of the study group shows that only 114 (28.8%) earn more than eighty thousand naira in a month, 113 (28.5%) earn between 51-80 thousand naira per month while 142 (35.9%) earn between 21- 50 thousand naira monthly.

Table 1: Characteristics of the Study Participants

Characteristics	Frequency	Percent
Gender		
Male	227	57.3
Female	169	42.7
Total	396	100
Age		
15 – 24	27	6.8
25 – 34	56	14.1
35 – 44	84	21.2
45 – 54	115	29.0
55 +	114	28.8
Total	396	100
Education Level		
Non formal	14	3.5
Primary	112	28.3
Secondary	213	53.8
Tertiary	57	14.4
Total	396	100
Years of Farming		
1 – 5	84	21.2
6 -10	142	35.9
11 -15	28	7.2
16 +	142	35.9
Total	396	100
Farming Type		
Subsistence	113	28.5
Commercial	283	71.5
Total	396	100
Income Per Month (in Naira)		
Less than 21,000	27	6.8
21,000 – 50,000	142	35.9
51,000 – 80,000	113	28.5
More than 80,000	114	28.8
Total	396	100

4.2 Knowledge of Alternative Preservation of Food with Indigenous Plant Parts

Alternate food preservation with indigenous plants among the study group was shown in Table 2. This was based on the knowledge shown on part of the plant they use in food preservation. All the participants that use bitterleaf plant use the leaves for food preservation. Among the participants that use lemon grass in food preservation, close to half (56:49.6%) responded that they use the leave part, and the whole plant, 29 (25.7%) use the root.

All the farmers that preserve food with chilli pepper use the fruit part (340: 100%). For those that use African black pepper plant for food preservation, 56 (28.3%) use the leave, 57 (28.8%) use the root and 114 (57.6%) use the seed. For the farmers that preserve food with Neem plant, 114 (66.7%) use the leave part, 85 (49.7%) use its flower part.

All those that preserve food with lime plant use the fruits (143: 100%). In addition, 58 (40.6%) of them also use the Skin/ peel. All the study participants that use castor beans to preserve food responded for the use of the seed (56: 100%).

Among the farmers that use ginger in food preservation, all of them responded that they use the rhizome (113: 100%). In addition, 56 (49.6%) responded that they use the whole plant, 29 (25.7%) use the skin/ peel. In terms of the use of moringa plant for food preservation, 28 (24.6%) among the users use the leaves and seed each while 85 (74.6%) use the flower part.

Table 2: Knowledge of Alternative Preservation of Food with Indigenous Plant Parts

Indigenous Plant Parts used for food preservation	**Leave**	**root**	**whole plant**	**bark**	**fruits**	**flower**	**Skin/ peel**	**Seed**	**rhizome**
	Freq (%)	**Freq (%)**	**Freq (%)**	**Freq (%)**	**Freq (%)**	**Freq (%)**	**Freq (%)**	**Freq (%)**	**Freq (%)**
Part of bitter leaf (n=256)	256 (100)								
Part of Lemom grass plant (n=113)	56 (49.6)	29 (25.7)	56 (49.6)						
Part of Chilli pepper plant (n=340)					340 (100)				
Part of African black pepper plant (n=198)	56 (28.3)	57 (28.8)						114 (57.6)	
Part of Neem plant (n=171)	114 (66.7)					85 (49.7)			
Part of Lime plant (n=143)					143 (100)		58 (40.6)		
Part of Castor beans (n=56)								56 (100)	
Part of Ginger plant (n=113)			56 (49.6)				29 (25.7)		113 (100)
Part of Moringa plant (n=114)	28 (24.6)					85 (74.6)		28 (24.6)	

4.3 Knowledge of Type of food Preserved with Indigenous Plant Parts and the Duration

Types of food preserved with indigenous plant parts and the durations as reported by the study group was shown in Table 3. The table shows that most of the plants are knowledgably used by the farmers to preserve different food items in different forms and to some length of times. For instance, for bitter leaf plant, 86 (21.5%) responded that they use it to preserve cassava in fresh form, of which 29 (32.6%) and 57(66.3%) of them responded that they use it to preserve cassava for with 7 days and 8 days to 2 month respectively. There were 28 (7.1%) farmers that use biter leaf plant to preserve melon and potatoes in fresh form for 8 days to 2 months. Over 43% responded that they use biter leaf plant to preserve palm wine in fresh form while 7.1% each use it for palm wine preservations in extract liquid form and dried form. All of them indicated that the preservations will last with 7 days.

Up to 14.1% showed knowledge of the use of lemon grass for preservation (extract liquid form) for yam, cassava, maize and potatoes for one week duration.

Many among the group studied indicated that plants like chilli paper can be used to preserve in dried form of which majority could be preserved for more than 6 months duration. The foods include rice (226: 57.1%), beans (312: 78.8%), maize (283: 71.5%) and melon (227: 57.3%). The table also contained the frequency of preservations in different forms and lasting durations for other plants such as African black pepper, neem Plant, lime plant, castor beans, ginger and moringa.

Table 3: Knowledge of Type of food Preserved with Indigenous Plant Parts and the Duration

Food	Extract Liquid	Powder	Dried Parts	Fresh Form	Within 7 days	8 days – 2 months	2-6 months	> 6 months
	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)
Biter leaf Plant								
Cassava				86 (21.5)	29 (32.6)	57 (66.3)		
Melon				28 (7.1)		28 (100)		
Potatoes				28 (7.1)		28 (100)		
Palm wine	28 (7.1)		28 (7.1)	172 (43.4)	228 (100)			
Kanu	28 (7.1)				28 (100)			
Zobo	28 (7.1)				28 (100)			
Soup				86 (21.7)	86 (100)			
Lemon Grass								
Yam	56 (14.1)				56 (100)			
Cassava	56 (14.1)				56 (100)			
Maize	56 (14.1)				56 (100)			
Melon			57 (14.4)		57 (100)			
Potatoes	56 (14.1)				56 (100)			
Chilli Pepper								
Rice			226 (57.1)			28 (12.4)	28 (12.4)	113 (50.0)
Beans			312 (78.8)			57 (18.3)	85 (27.2)	170 (54.5)
Yam		58 (14.6)				58 (100)		
Maize			283 (71.5)			28 (9.9)	85 (30.0)	170 (60.1)
Melon			227 (57.3)			28 (12.3)	57 (25.1)	142 (62.6)
Potato		29 (7.3)				29 (100)		
Soap		28 (7.1)	28 (7.1)		56 (100)			

Table 3 continued

Food	Extract Liquid	Powder	Dried Parts	Fresh Form	Within 7 days	8 days – 2 months	2-6 months	> 6 months
	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)
African black pepper								
Kunu		85 (21.5)			85 (100)			
Zobo		85 (21.5)			85 (100)			
Soup	57 (14.4)	85 (21.5)		28 (7.1)	170 (100)			
Neem Plant								
Rice			113 (28.5)	57 (14.4)			57 (33.5)	142 (83.5)
Beans			113 (28.5)	57 (14.4)			57 (33.5)	142 (83.5)
Maize	29 (7.3)	113 (28.5)	28 (7.1)				57 (33.5)	142 (83.5)
Mellon	29 (7.3)	113 (28.5)	28 (7.1)				57 (33.5)	142 (83.5)
Lime Plant								
Yam	114 (28.8)		29 (7.3)		57 (39.9)	86 (60.1)		
Cassava	29 (7.3)					29 (100)		
Potatoes	29 (7.3)		29 (7.3)		29 (50.0)	29 (50.0)		
Kunu	57 (14.4)				57 (100)			
Zobo	57 (14.4)				57 (100)			
Castor Beans								
Rice			28 (7.1)				28 (100)	
Ginger								
Kanu	171 (43.2)	28 (7.1)			199 (100)			
Zobo	171 (43.2)	34 (7.1)			199 (100)			
Moringa								
Fish	84 (21.2)				84 (100)			
Meat	84 (21.2)				84 (100)			
Zobo	56 (14.1)				56 (100)			
Soup	56 (14.1)				56 (100)			

4.4 Perception on the use of indigenous plants for food preservation

The participants' perception on the use of indigenous plants for food preservation was shown in Table 4. The table shows that clear majority (321: 81.1%) believe in efficacy of indigenous plants for food preservation. More than half of the study group (232: 58.6%) indicated that the indigenous plants they often used for food preservations were herbs, while 127 (32.1%) responded for spices.

Up to 254 (64.1%) of the respondents have perception that the indigenous plants are safe and that informed their choice of the use of such plants for food preservation while 63 (15.9%) do so as a result of less cost for the plants. Clear majority (280: 70.7%) opted for support for integration of indigenous plants for commercial food preservation. Those who were of positive perception that the use of indigenous plants is a good alternative to chemical preservative were 243 (61.4%), while clear majority (83.1%) were of the view that the use of some indigenous plants can help to keep the quality and taste of food.

There were 51.8% who showed positive perception that the use of some indigenous plants can help to keep the colour of food while 39.6% were not sure. Similarly 58.53 were of the view that the use of some indigenous plants can help to stimulate appetite and create visual appeals to food than other synthetic preservatives while 33.1% were not sure. Those with positive perception on the use of some indigenous plants for producing anti-diarrhoeal effect on food during preservation were 194 (49.1%) in all.

Figure 1 shows that the overall positive perception on the use of indigenous plants for food preservation was found to be relatively high (65.1%) among the study group.

Table 4: Perception on the use of indigenous plants for food preservation

Perception	Frequency (n=396)	Percent (%)
Believe in efficacy of indigenous plants for food preservation		
Yes	321	81.1
No	23	5.8
Not sure	52	13.1
What informed the choice of the use of indigenous plants for food preservation than chemical preservatives		
It is safe	254	64.1
It is effective	53	13.4
it is not costly	63	15.9
Others	26	6.6
Support for integration of indigenous plants for commercial food preservation		
Yes	280	70.7
No	19	4.8
Not sure	97	24.5
The use of indigenous plants is a good alternative to chemical preservative		
Yes	243	61.4
No	30	7.6
Not sure	123	31.1
Use of some indigenous plants can help to keep the quality & taste of food		
Yes	329	83.1
No	67	16.9
The use of some indigenous plants can help to keep the colour of food		
Yes	205	51.8
No	34	8.6
Not sure	157	39.6
The use of some indigenous plants can stimulate appetite and create visual appeals to food than other synthetic preservatives		
Yes	231	58.3
No	34	8.6
Not sure	131	33.1
The use of some indigenous plants can produce anti-diarrhoeal effect on food during preservation		
Yes	194	49.0
No	30	7.6
Not sure	172	43.4

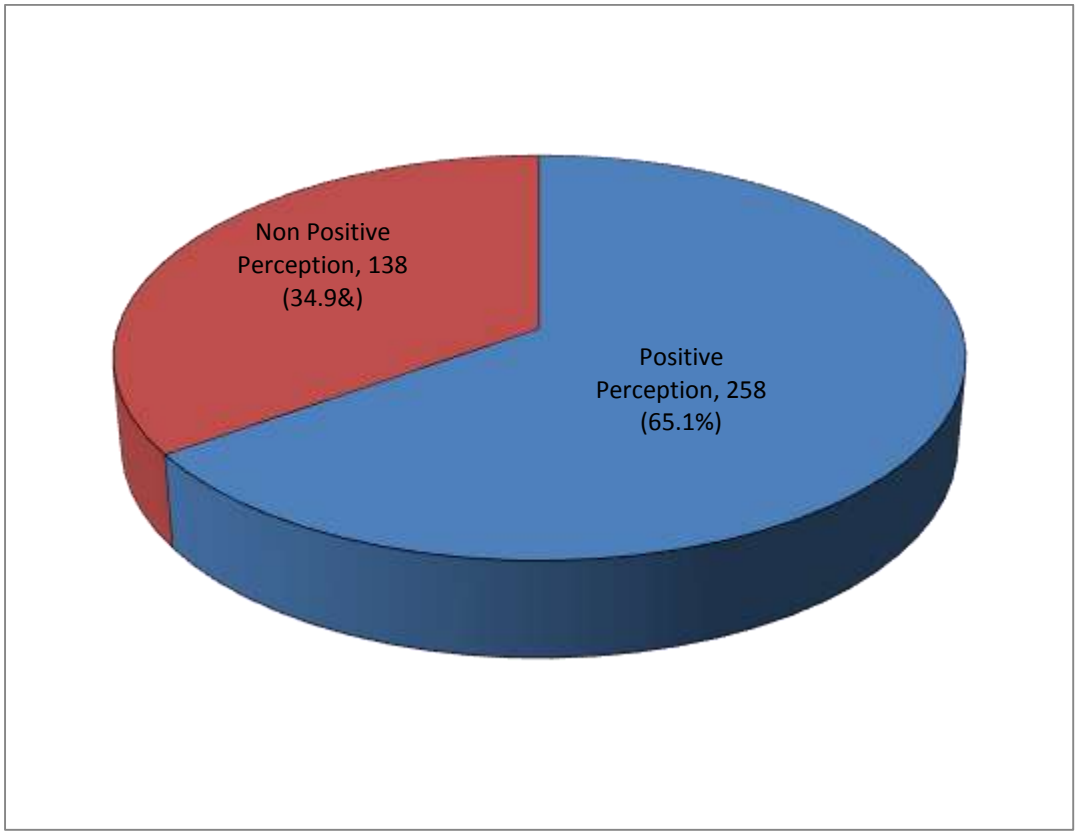

Figure 1: Overall Perception on the use of indigenous plants for food preservation

4.5: Utilization of Indigenous Plants for Food preservation

Figure 2 shows that overwhelm majority of the study group (369: 93.2%) use indigenous plants for food preservation with only 27 (6.8%) indicating that they do not such plants for food preservation.

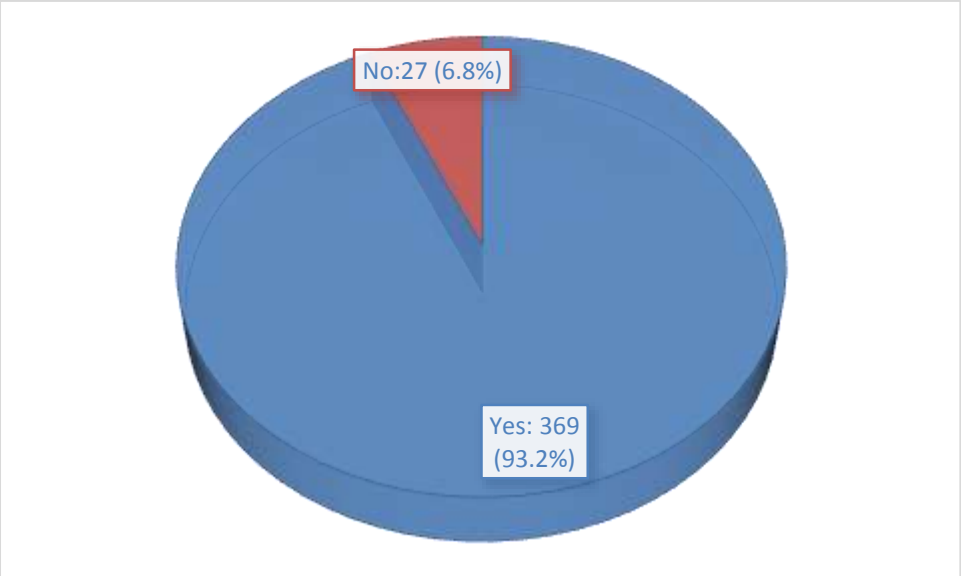

Figure 2: Pie Chart representation of the use of Indigenous Plants for Food preservation among the studied Population

4.6 Type of indigenous plants used for food preservation

Those who responded that they use Chilli pepper (ose bekee) for preservation were the largest (340: 85.9%), followed by the responses on the use of bitterleaf (Onuigbo) at 256 (64.6%) and black pepper (Uziza) at 198 (50.0%) (Table 5). The response for the use of Castor beans (Mkpuru Ogiri) was only 56 (14.1%) and the use of ginger and lemon grass were 113 (28.5%) each.

Table 5: Type of indigenous plants used for food preservation

Indigenous plants	Frequency	Percent
Bitterleaf (Onugbo)	256	64.6
Lemon grass (Achara tea)	113	28.5
Chilli pepper (Ose Bekee)	340	85.9
African black pepper (Uziza)	198	50.0
Neem plant (Dogoyaro)	171	43.2
Lime	143	36.1
Castor Beans (Mkpuru Ogiri)	56	14.1
Ginger	113	28.5
Moringa	114	28.8
Others	28	7.1

4.7 Relationship between the use of Indigenous Plants and Demographic Factors

In table 6, both male and female participants are well utilising the indigenous plants, yet significant difference exist in the use of the plants by gender (P =0.0001, χ^2 (df) =21.57 (1)). While 200 (88.1%), of the males make use of the indigenous plants all the women studied (169:100%) indicated that they use the plants.

In terms of age, while all other age group as from 35 years and above are making use of the indigenous plants, the youngest age group among them seems not to be doing so. All the 27 participants that responded that they do not use indigenous plants were below 25 years of age which is contrary to perfect utlisation (100%) on other higher age group in the study. This difference is found significant (P =0.0001, □2 (df) = 498.0 (4)

Education is also a significant associating factor of utlisation of indigenous plant in this study (P =0.0001, □2 (df) = 73.47 $(3)^{L}$)), Similarly, all the 27 that do not use indigenous plants never had formal education (24.1% of that group). Among those that never had formal education, 85 (75.9%) utlise the plants which is lower to 100% obtained in any other level of as from primary to tertiary.

Just as observed in age, income earning per month is significant factor of utlisation (P =0.0001, χ^2 (df) = 396 (3)). and the lowest income group did not utilise the indigenous plats against the result obtained among the higher income groups where the participants utilise the plants.

Table 6: Relationship between the use of Indigenous Plants and Demographic Factors

Socio	Making use of Indigenous Plants					Chi sq:	
demographics	**Yes**	**%**	**No**	**%**	**Total**	χ^2 **(df)**	***P***
Gender							
Male	200	88.1	27	11.9	227		
Female	169	100	0	0.0	169		
Total	369	93.4	27	6.8	396	21.57 (1)	0.0001
Age							
15 – 24	0	0.0	27	100	27		
25 – 34	56	100	0	0.0	56		
35 – 44	84	100	0	0.0	84		
45 – 54	115	100	0	0.0	115		
55 +	114	100	0	0.0	114		
Total	369	93.4	27	6.8	396	396.0 (4)	0.0001
Education Level							
Non formal	85	75.9	27	24.1	112		
Primary	14	100	0	0.0	14		
Secondary	213	100	0	0.0	213		
Tertiary	57	100	0	0.0	57		
Total	369	93.4	27	6.8	396	73.47 (3)^{L}	0.0001
Income Per Month (in Naira)							
Less than 21,000	0	0.0	27	100	27		
21,000 – 50,000	142	100	0	0.0	142		
51,000 – 80,000	113	100	0	0.0	113		
More than 80,000	114	100	0	0.0	114		
Total	369	93.4	27	6.8	396	396 (3)	0.0001

* indicate significance difference at 5% , L indicates that Likelihood ratio Chi-square was used when Chi-square assumption was not met.

4.8 Differences in Utilisation of Indigenous plants in Subsistence and Commercial Farming

Table.7 shows that significant difference exists in the utilisation of indigenous plants by type of farming. Utilisation is slightly lower among those engaged in subsistence farming (86: 76.1%) compared to those engaging on commercial farming type where it appeared perfect (283: 100%).

Table 7: Differences in Utilisation of Indigenous plants in Subsistence and Commercial Farming

	Making use of Indigenous Plants					Chi sq:	
Type of Farming	**Yes**	**%**	**No**	**%**	**Total**	χ^2 **(df)**	***P***
Subsistence	86	76.1	27	23.9	113		
Commercial	283	100	0	0.0	283		
Total	369	93.4	27	6.8	396	72.67 (1)	0.0001

4.9: Differences in Utilisation of Indigenous Plants based on Farming Experience

On Table 8, the years of farming experience is a significant associating factor of utlisation of indigenous plant significant (P =0.0001, χ^2= 107.62, df.=3),

Differences exist in utilisation between the 1 -5 years of experience and the other higher level of farming experience. While 68% utlise the plants in the 1 – 5 years' experience, 100% utilise such plants among those with higher years of experiences.

Table 8: Differences in Utilisation of Indigenous Plants based on Farming Experience

Years of Farming	Making use of Indigenous Plants					Chi sq: χ^2 (df)	*P*
	Yes	**%**	**No**	**%**	**Total**		
1 – 5	57	68.0	27	32.0	84		
6 -10	142	100	0	0.0	142		
11 -15	28	100	0	0.0	28		
16 +	142	100	0	0.0	142		
Total	369	93.4	27	6.8	396	107.62 (3)	0.0001

4.10 Discussion of Findings

This chapter discussed the major findings of the research work against the background of objectives set, literature review, research questions and empirical studies.

Research question one sought to find out the response on knowledge of alternate preservation of food with indigenous plants among the study group, which was based on the knowledge shown on part of the plant they use in food preservation. From the responses, all the respondents (100%) were knowledgeable of using the leafy part of bitter leaf plant for food preservation, 100% were aware of the use of fruit part of chilli pepper for food preservation while 100% were knowledgeable of lime plant through use of the fruit part for food preservation. Among the participants that use lemon grass in food preservation, close to half (49.6%) responded to the use the leafy part, 25.7% attested to the whole plant while (25.7%) use the root. Among the farmers that use ginger in food preservation, all the respondents (100%) perceived the use of the rhizome part. For those that use African black pepper plant for food preservation, (28.3%) attested to the use the leafy part, (28.8%) agreed to the use of the root part while (57.6%) indicated the use of the seed part. For the farmers that preserve food with Neem plant, (66.7%) acknowledge use of the leafy part while (49.7%) attested to the use of its flower part. For the farmers that preserve food with neem plant, (66.7%) attested to the use of the leafy part

while (49.7%) attested to use of its flowery part. All the study participants (100%) attested to the use of castor beans to preserve food by the use of the seed. Among those knowledgeable of moringa, (74.6%) attested to the use of the flower part while (24.6%) among the users attested to use of the leaves and seed each.

The results implies that majority of the respondents were knowledgeable of the alternate preservation of food with indigenous plants. They acknowledge the following indigenous plants: bitter leaf (*onugbu* in Igbo) (leaf), chilli pepper (*ose bekee* in Igbo) (fruit), lemon grass (leaf, whole plant and root), ginger (rhizome), castor beans (seed), Africa pepper (*Uziza* in Igbo) (seed, root and leaf) and neem plant (*Dogoyaro* in Hausa) (leaf and flower). The result of this study implies that with the exception of root and rhizome, aerial plant parts were most commonly recommended by the respondents for preserving food: leaves, fruits, seeds and flowers. In agreement with the result, Malla, Gauchan and Chhetri (2015) and Al-Fatimi (2019) reported that the aerial parts of plant (leaves, flowers and fruits) are most commonly used by people to extract bioactive molecules. The preferred use of the aerial part of plants could be due to easy harvesting of this part of the plant compared to the roots. In addition, the leaves are the seat of most types of volatile molecules (monoterpenes, sesquiterpenes, aldehydes, ketones and alcohols) and non-volatile phytochemicals (tannins, mucilages, flavonoids, and so on). The abundant use

of the leaves, roots, fruits, seed and flowers of indigenous plants by local people promotes preservation of natural resources. However, most indigenous plants are threatened by major factors such as urbanization, unforeseen climatic changes, expansion of new agricultural lands, overgrazing and unscientific harvesting methods, which necessitates taking adequate measures to preserve the plant heritage through the use of domesticated of the indigenous plants revealed in this study.

The above findings disagreed with the submission by Olanipekun and Agbadaola (2013) on ethnobotanical studies of knowledge of plants used for preservation of plant products in Ikere Ekiti, Ekiti State, Nigeria. The study revealed that the respondents' indigenous knowledge were poor. The study results agree with findings of Rahman, Fardusi and Reza (2011) on traditional knowledge and use of medicinal plants. Their study revealed high knowledge of indigenous plant by the inhabitants of the study area. In their study, a total of 31 medicinal plant species were recorded with the help of tribal people of the area as mostly collected from the forest and were found to be used for preserving food and curing ailments. This knowledge is handed down orally from generation to generation, there is a great possibility that the knowledge may be lost over time. The conservation of indigenous knowledge can help conserve these indigenous plants species from extinction. The implication is depreciating knowledge of indigenous plant could lead to endangering most plants species,

thus, strategies that could help in conserving them should be proposed by the government to safeguard these endangered plant species.

The overall positive perception on the use of indigenous plants for food preservation was found to be relatively high (65.1%) among the study group. The study results revealed that majority of the respondents perceived efficacy of the use of indigenous plants for food preservation (81.1%), good alternative to chemical preservative, it is safer (64.1%), it can help to keep the quality and taste of food (83.1%), retain colour of food (51.8%) and 58.53% perceived that the use of some indigenous plants can help to stimulate appetite and create visual appeals to food than other synthetic preservatives while 49.1% attested to the producing anti-diarrhoeal effect on food during preservation.

Some studies have been conducted around the globe to prove the efficacy of plant products, and various compounds isolated from these plants are secondary metabolites which possess antimicrobial and medicinal properties (Raybaudi-Massilia et al., 2009; Ota & Ulrih, 2017). This finding agrees with findings in research carried out by Rahman, Fardusi and Reza (2011) who attested to the efficacy of indigenous plants utilized food preservation, retaining the quality and taste of food. The perception of naturalness drives the people towards the food without chemical preservatives. However, modernization coupled with the change in the life style of the people shifts them towards the use of ready-to-use food.

The study investigated assessment of types of indigenous plants used for food preservation. The study revealed that 93.2% use indigenous plants for food preservation. However, 85.9% respondents attested to the use Chilli pepper (ose bekee) for preservation were the largest, followed by the responses on the use of bitterleaf (Onuigbo) at (64.6%) and black pepper (Uziza) at (50.0%). The response for the use of ginger and lemon grass were (28.5%) each while use of Castor Beans (Mkpuru Ogiri) was only (14.1%). Moreover, more than half of the respondents confirm the use of chilli pepper (85.9%), bitterleaf (64.6%) and black pepper (50.0%) while less than half of the respondents attested to ginger and lemon grass (28.5%) and castor beans (14.1%).

The above findings do completely justify study by Onyango et al. (2014), where the majority of the respondents utilized indigenous plants for various purposes. They researchers opined that this indicates that these indigenous plants are rich in phytochemicals and minerals therefore, can be exploited to develop nutritive food preservatives because phytochemicals have both antimicrobial and antioxidant properties. These plants can also be processed to obtain products that could substitute the chemical preservatives in the market, now that consumers are showing greater preference for products preserved with natural products. The result is in disagreement with the study by Olanipekun and Agbadaola (2013) findings, whose study revealed under-utilization of indigenous plants for preservation. This implies that the potentials hidden in

most indigenous plants are unutilized. Hence, government should help to harness the potentials of these indigenous plant species through collaboration of Ministry of Agriculture and National Agency for Food and Drug Administration and Control (NAFDAC).

The study sought to ascertain the response on forms of food preserved with indigenous plant parts and the duration. The study showed that most of the plants were used by the farmers to preserve different food items in different forms and to some length of times. Results revealed that more than half of the respondents attested using chilli pepper in preserving dried form of rice (57.1%), beans (78.8%), maize (71.5%) and melon (57.3%) for more than 6 months duration. In the same vein, more than half of the respondents (66.3%) utilised bitter leaf to preserve some food items like fresh form of cassava for duration of 8 days to 1 month. While less than half of respondents were utilised bitter leaf in preserving melon and potatoes in fresh form for 8 days to 2 months. Less than half attested to the use of lemon grass in preserving food items such as yam, cassava, maize and potatoes for one week duration. In the same vein, very few of the respondents (14.1%) indicated the use of lemon grass (extract liquid form) for preserving yam, cassava, maize and potatoes for one week duration.

The results corroborates with the submissions of Rahman, etal., (2016), who revealed majority attesting to indigenous plants such as neem, garlic, tobacco,

kappettiya, ginger and many others are being utilized to control and manage the pest or disease of different plants serving as preservatives for food such as rice, vegetables, serving as alternative good source of chemical pesticide due to their safe, eco-friendly and more compatible properties.

Results revealed that significant difference exist in the use of the plants by gender. Significant difference was also found in use of the indigenous plants among different age groups studied, however the level of good knowledge was highest among 35 -44 years old. This suggests that this aged group who are at the peak of their education and experience have contributed to the level of utilisation they had. However, findings of Agea, Obua, Waiswa, Okia and Okullo (2010) submitted that age did not influence knowledge of indigenous plants among farmers. Results differences could attributed to study settings and time of study.

There was significant difference in the level of knowledge of farmers on knowledge of indigenous plants according to education. The knowledge for the indigenous plants was highest among the tertiary secondary and primary education participants. This suggest that education level has a significant effect on knowledge in this study. This finding is consistent with other reports that education increases people's environmental awareness and appreciation of the value of trees (Agea et al., 2019).

Significant difference was found indicating variation in the utilization of

indigenous plants based on years of farming experience. Comparisons test shows that significant difference in utilization was only found between those with farming experience 6-10 year and those with at least 16 years of farming experience. This suggest the role of experience of the respondents could have contributed to it. Experience they say is the best teachers, years of experience gathered should have generated more to knowledge and indigenous plant utilisation. This results corroborates with the findings of Torimiro, Ayinde, Koledoye and Oyedele (2014), whose reported found the influence of farming experience on utilization of indigenous plants.

Significant difference in utilization of indigenous plants was found between those involved in farming for subsistence purposes and those involved in farming commercial purposes. Utilisation for indigenous plants was found higher in the commercial farming (100%) compared to that of the subsistence farming (76.1%). This result suggest that subsistence farmers may utilize this indigenous plants for personal use less than the commercial farmers who do farming for commercial purposes. This is supported by the findings of Agea et al., (2019), who submitted size of farm has an influence in the knowledge of indigenous plants.

Income earning per month was significant factor of utlisation of indigenous plants among the respondents. The lowest income group did not utilise the indigenous plants against the result obtained among the higher income groups

who utilize plants. This implies economic power has a role in encouraging the utilization of indigenous plants for food preservation.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Conclusion made from the study, indicates there is adequate indigenous knowledge, relatively high perception and utilization of indigenous plants for food preservation. The result obtained in this study has shown the potential of botanicals in preserving the quality and quantity of food and plants produce. Hence, current knowledge and new findings about this promising plant products used for preservation needs to be transformed into practical applications which are acceptable by the users. Neglecting this can lead to a negative setback for the farmers and local residents which could result to decreasing interest to the use of natural preservatives. It is expected that ministries, stakeholders and health professionals technocrats plan programmes in line with these revelations. Proactive interventions should encourage more utilization of indigenous plants.

5.2 Recommendations

Based on the findings and recommendations, the following were drawn:

1. Indigenous plants revealed in this study should be processed in forms and products that will substitute the chemical preservatives in the market, now that consumers are showing greater preference for products preserved with natural products.
2. Seminars and workshops should be organized and sustained periodically

to sensitize local people and the general public on the efficacy of indigenous plants for food preservation and the dangers of patronizing western food preserved with synthetic preservatives.

3. It is therefore, the opinion of this researcher that seminars on food security be regularly organized not only for public but to the entire stakeholders in food service operations in the society. The food vendors, health workers and non-governmental bodies should collaborate to contribute in ensuring that appropriate indigenous plants utilization are maintained in the society for the benefit of all.
4. Government is urged to promote indigenous foods and their importance in ensuring household food and nutrition security as well as being direct and indirect source of income, particularly for rural households.
5. Future research should focus on the promotion of indigenous plants so that they can know their importance in addressing food and nutrition security.

5.3 Contribution to Knowledge

Indigenous knowledge and perception is mainly known and practiced by elderly members of the communities and there is risk that it might eventually disappear, as young generations may not see its relevance. Therefore, the importance of indigenous plants in ensuring food processing and preservation should be documented for future custodians to access. Traditional/indigenous foods

provide inexpensive, safe, nutritious foods throughout the whole year thus boosting overall food security. Traditionally, they also provide an economic means of preserving food thus making it available during the period of scarcity. Unfortunately, despite these benefits, Indigenous knowledge and utilization is fast eroding. Factors enhancing this gradual destruction include influence of western culture, changing socio-cultural status, lack of documentation, high illiteracy level. Hence, there is an urgent need to preserve and promote Indigenous knowledge as a very important resource. All stakeholders must therefore be involved - governmental, and non-governmental bodies as well as the local people themselves. In addition, the future of indigenous plants will influence the medical practice, considering the occurrence of new pathogens and diseases, which calls for alternative or complementary medicine. The rising tide in antibiotic resistance by microorganism has raised significant concern in the medical field and, thus, an urgent demand for the discovery of safe, natural compounds in this postgenomic era. The use of indigenous plants as nutraceuticals and functional foods is on the increase, as means of ensuring preventive medicine and finding a solution to this global concern of evolution of drug-resistant microorganisms.

5.4 Suggestions for Further Research

1. Knowledge and behaviour of public towards indigenous plants
2. Study on the use of indigenous plants by the public.

5.5 Limitations to the Study

1. The study was constrained by limited time for the research and logistic problem encountered in the process of distributing my research instruments.
2. There may be some faking in the responses made by the respondents in filing the questionnaire and this may influence the findings of this work.

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Appendix A

Introductory Letter

Department of Public Health
Federal University of Technology,
Owerri,
Imo State.
3rd October, 2021.

Dear Respondent,

The researcher is a post-graduate student of the above named Department and Institution. She is currently undertaking a research work on the topic: **"Study on the Use of indigenous plants for food Preservation among farmers in Ivo LGA, Ebonyi State".**

Please kindly respond to the questions below as they apply to you. Data supplied will be treated with utmost confidentiality. Please do not write your name.

Thanks for your anticipated cooperation.

Yours faithfully,

Adiruo, Akunna
(Researcher)

_____
(Supervisor)

QUESTIONNAIRE

Instruction: Please tick (✓) against the spaces provided the options that applies to you in all sections.

SECTION A: Demographic characteristics

1) What is your gender?
    a) male [ ]
    b) female [ ]
2) What is your area of age group?
    a) 15 – 24 years [ ]
    b) 25 – 34 years [ ]
    c) 35 – 44 years [ ]
    d) 45 – 54 years [ ]
    e) Above 55 years [ ]
3) What is your educational level?
    a) No formal education [ ]
    b) Primary education [ ]
    c) Secondary education [ ]
    d) Tertiary education [ ]
4) What is your year(s) of farming experience?
    a) 1 – 5 years [ ]
    b) 6 – 10 years [ ]
    c) 11 – 15 years [ ]
    d) 16 – 20 years [ ]
5) What type farming do you practice?
    a) Subsistence farming [ ]
    b) Commercial farming [ ]
6) What is your monthly income
    a) Less than N10,000
    b) N10,000 – N20,000
    c) N21,000 – N50,000
    d) N51,000 – N80,000
    e) More than N80,000

Section B: Knowledge of alternative preservation of food with indigenous plant parts

1. Which part of bitterleaf plant do you use for food preservation?
    a) Leaves[ ]
    b) Stem [ ]
    c) Roots[ ]
    d) Wholeplant [ ]
    e) Bark [ ]
2. Which part of Lemon Grass plant do you use for food preservation ?
    a) Roots[ ]
    b) Leaves [ ]
    c) Whole plant [ ]
    d) Roots [ ]
    e) Fruit [ ]

3. Which part of Chilli Pepper plant do you use for food preservation?
    e) Leaves [ ]
    f) Stems [ ]
    g) Roots [ ]
    h) Whole plant [ ]
    i) Fruits [ ]
4. Which part of African Black Pepper plant do you use for food preservation?
    c) Seeds [ ]
    d) Leaves [ ]
    c) Roots [ ]
    d) Whole plant [ ]
    e) Stem [ ]
5. Which part of Neem plant do you use for food preservation?
    1) Fruits [ ]
    2) Flowers [ ]
    3) Leaves [ ]
    4) Roots [ ]
    5) Bark [ ]
6. Which part of Lime plant do you use for food preservation?
    f) Fruits [ ]
    g) Leaves [ ]
    h) Skin/Peels [ ]
    i) Roots [ ]
    j) Seeds [ ]
7. Which of part of Castor Beans do you use for food preservation?
    7) Leaves [ ]
    8) Seeds[ ]
    9) Bark [ ]
    10) Stem [ ]
    11) Whole plant [ ]
8. Which part of Ginger plant do you use for food preservation?
    a. Whole plant [ ]
    b. Rhizome [ ]
    c. Leaves [ ]
    d. Roots [ ]
    e. Skin/Peels [ ]
9. Which part of Ginger plant do you use for food preservation?
    a. Whole plant [ ]
    b. Flower [ ]
    c. Leaves [ ]
    d. Roots [ ]
    e. Seeds [ ]

Section C: **Perception on the use of indigenous plants for food Preservation**

1) Do you believe in the efficacy of indigenous plants in food preservation?
    a) Yes [ ]
    b) No [ ]
    c) Not sure [ ]

2) What informed your choice to use indigenous plants for food preservation than chemical preservatives?
   a) It is safe [ ]
   b) It is effective [ ]
   c) It is not costly [ ]
3) Do you support the integration of indigenous plant into commercial food preservation?
   a) Yes [ ]
   b) No [ ]
   c) Not sure [ ]
4) What form of indigenous plant is more often used for food preservation?
   a) Spices [ ]
   b) Herbs [ ]
   c) Others [ ]
5) The use of indigenous plant used is a good alternative to chemical preservative
   a) Yes [ ]
   b) No [ ]
   c) Not sure [ ]
6) The use of some indigenous plants can help to keep the quality and taste of food
   a) Yes
   b) No
7) The use of some indigenous plant can help keep the colour of food
   a) Yes
   b) No
8). The use of indigenous plant can stimulate appetite and create visual appeals to food than other synthetic preservatives
   a) Yes
   b) No
9). The use of indigenous plant can produce anti-diarrhoeal effect on food during preservation
   a) Yes
   b) No

Section D: What type of indigenous plants do you use for food Preservation?

1) Do you use indigenous plant parts in food/farm products preservation?

   Yes [ ] No [ ]

2) If yes pick from the box below which of them you use:

S/N	**Types of indigenous plants used for food preservation**	**Yes**	**No**
i.	I use Bitterleaf (Onugbu)		
ii.	I use Lemon grass(Achara tea)		
iii.	I use Chilli pepper (Ose Bekee)		
iv.	I use African black pepper (Uziza)		
v	I use Neem plant (Dogoyaro)		
vi	I use Lime		
vii	I use Castor Beans (Mkpuru Ogiri)		

viii	I use Ginger		
ix	I use Moringa		
x	Any other		

Section E: What type of food do you preserve with indigenous plant parts and the duration?

a. Which type of food do you preserve with Bitterleaf plant and duration?

	Form				**Duration of storage**			
Food	Extract liquid)	Powder	Dried parts	Fresh forms	Within 7 days	8 days - 2 months	2 - 6 months	More than 6 months
Rice								
Beans								
Yam								
Cassava								
Maize								
Melon								
Potatoes								
Palm wine								
Kunu								
Zobo								
Soup								

b. Which type of food do you preserve with Lemon Grass and duration?

	Form				**Duration of storage**			
Food	Extract	Powder	Dried parts	Fermented forms	Within 7 days	8 days - 2 months	2 - 6 months	More than 6 months
Rice								
Beans								
Yam								
Cassava								
Maize								
Melon								
Potatoes								
Palm wine								
Kunu								
Zobo								
Soup								

c. Which type of food do you preserve with Chilli Pepper and duration?

	Form				**Duration of storage**			
Food	Extract (liquid)	Powder	Dried parts	Fresh forms	Within 7 days	8 days - 2 months	2 - 6 months	More than 6 months
Rice								
Beans								

Yam								
Cassava								
Maize								
Melon								
Potatoes								
Palm wine								
Kunu								
Zobo								
Soup								

d. Which type of food do you preserve with African Black Pepper Plant and duration?

	Form				**Duration of storage**			
Food	Extract (liquid)	Powder	Dried parts	Fresh forms	Within 7 days	8 days - 2 months	2 - 6 months	More than 6 months
Rice								
Beans								
Yam								
Cassava								
Maize								
Melon								
Potatoes								
Palm wine								
Kunu								
Zobo								
Soup								

e. Which type of food do you preserve with Neem plant and duration?

	Form				**Duration of storage**			
Food	Extract (liquid)	Powder	Dried parts	Fresh forms	Within 7 days	8 days - 2 months	2 - 6 months	More than 6 months
Rice								
Beans								
Yam								
Cassava								
Maize								
Melon								
Potatoes								
Palm wine								
Kunu								
Zobo								
Soup								

f. Which type of food do you preserve with Lime plant and duration?

	Form				Duration of storage			
Food	Extract (liquid)	Powder	Dried parts	Fresh forms	Within 7 days	8 days - 2 months	2 - 6 months	More than 6 months
Rice								
Beans								
Yam								
Cassava								
Maize								
Melon								
Potatoes								
Palm wine								
Kunu								
Zobo								
Soup								

g. Which type of food do you preserve with Castor Beans (Mkpuru ogiri in Igbo) and duration?

	Form				Duration of storage			
Food	Extract	Powder	Dried parts	Fermented forms	Within 7 days	8 days - 2 months	2 - 6 months	More than 6 months
Rice								
Beans								
Yam								
Cassava								
Maize								
Melon								
Potatoes								
Palm wine								
Kunu								
Zobo								
Soup								

h. Which type of food do you preserve with Ginger and duration?

	Form				Duration of storage			
Food	Extract	Powder	Dried parts	Fermented forms	Within 7 days	8 days - 2 months	2 - 6 months	More than 6 months
Rice								
Beans								
Yam								
Cassava								
Maize								

Melon								
Potatoes								
Palm wine								
Kunu								
Zobo								
Soup								

i. Which type of food do you preserve with Moringa and duration?

	Form				**Duration of storage**			
Food	Extract	Powder	Dried parts	Fresh forms	Within 7 days	8 days - 2 months	2 - 6 months	More than 6 months
Rice								
Beans								
Yam								
Cassava								
Maize								
Melon								
Potatoes								
Fish								
Meat								
Zobo								
Soup								

FEDERAL UNIVERSITY OF TECHNOLOGY
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Head of Department: Dr. U. M. Chukwuocha
B.Sc, MPH, Ph.D.

December 8th, 2021

Our Ref: FUT/SOHT/PUH/CS.006/VOL. 1
Your Ref:

Dear Sir/Ma,

LETTER OF INTRODUCTION

The bearer **ADIRUO AKUNNA STEPHANIE** with Registration number **20174081888** is a bona-fide Post graduate student of Federal University of Technology Owerri, of the Department of Public Health. As part of requirement for post graduate students, she is expected to carry out well-articulated research.

Accordingly, **ADIRUO AKUNNA STEPHANIE** is seeking to carry out her research on the topic: **STUDY ON THE USE OF INDIGENOUS PLANTS' PARTS FOR FOOD PRESERVATION AMONG FARMERS IN IVO LOCAL GOVERNMENT AREA, EBONYI STATE.** We would appreciate your kind assistance towards the realization of this Compulsory requirement for her post graduate program.
Please give her the necessary assistances she requires for a successful program.

Nigerian Agricultural Cooperatives and Rural Development, Ivo LGA, Ebonyi State

Your Ref.....
Our Ref.....

Date: 9th February, 2022

Mrs Akunna Adiruo
Researcher,
Post-Graduate Student,
FUTO, Owerri.

RE: APPROVAL LETTER TO CARRY OUT A RESEARCH ON STUDY ON THE USE OF INDIGENOUS PLANTS' PARTS FOR FOOD PRESERVATION AMONG FARMERS IN IVO LGA, EBONYI STATE

Following your request to conduct a research on **STUDY ON THE USE OF INDIGENOUS PLANTS' PARTS FOR FOOD PRESERVATION AMONG FARMERS IN IVO LGA, EBONYI STATE**. I wish to inform you that approval has been given to carry out your research.

You are therefore advised to liaise with the farmers in their localities for their support as you conduct this study.

Please be assured of my esteemed regards

Mr John Emeh
Secretary

APPENDIX C
Workings of Reliability Result

Week x	Week y	Rx	Ry	d	d^2
15	13	5.5	6	-0.5	0.25
12	10	11.5	10.5	1	1
9	6	15	19.5	-4.5	20.25
15	8	5.5	17	-11.5	132.3
6	6	18.5	19.5	-1	1
9	9	15	13.5	1.5	2.25
15	12	5.5	8	-2.5	6.25
12	9	11.5	13.5	-2.0	4
18	16	2	2.5	-0.5	0.25
14	12	9	8	1	1
15	12	5.5	8	-2.5	6.25
20	16	1	2.5	-1.5	2.25
6	8	18.5	17	1.5	2.25
15	15	5.5	4.5	1.0	1
12	10	11.5	10.5	1.0	1
6	8	18.5	7	1.5	2.25
9	9	15	13.5	1.5	2.25
12	15	11.5	4.5	7	49
6	9	18.5	13.5	5	25
15	18	5.5	1	4.5	20.25
				Total	**291.55**

Rho = 1 - $\frac{6\sum d^2}{n(n^2-1)}$

Rho = 1 - $\frac{6(291.55)}{20(20^2-1)}$

Rho = 1 - $\frac{1749.3}{20(400-1)}$

Rho = 1 - $\frac{1749.3}{7980}$

Rho = 1 – 0.22

= **0.78**

APPENDIX D

Pictures of Indigenous Plants Used for Food Preservation

Bitter leaf (*Onugbo*)

Chilli pepper (*Ose bekee*)

Ginger

African black pepper (*Uziza*)

Neem plant (*Dogoyaro*)

Lime (*oroma nkirisi*)

Lemon grass (Achara tea)

Moringa plant

Castor beans