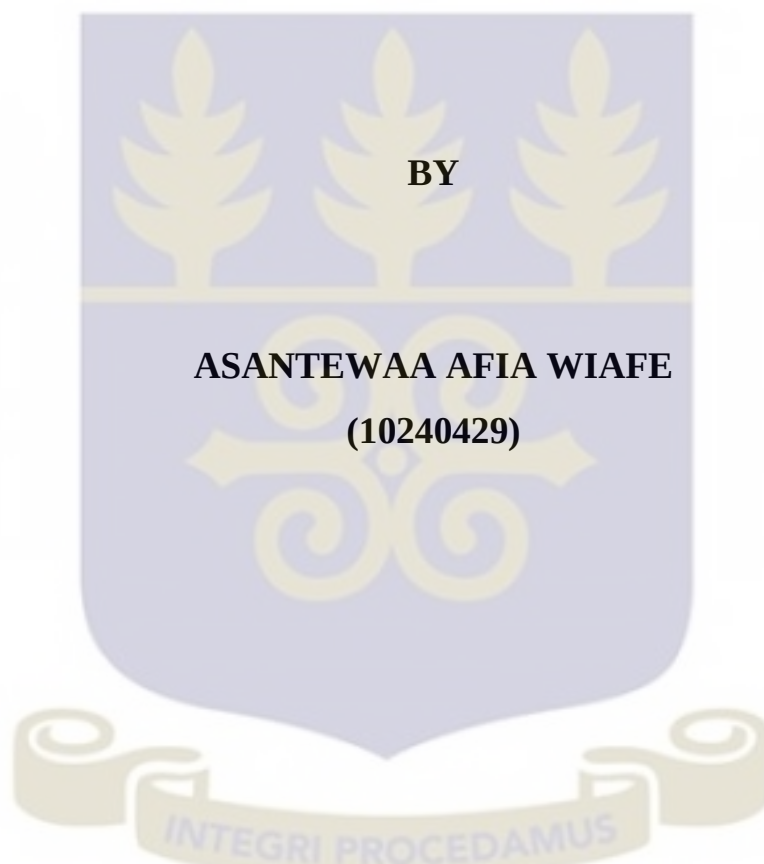


**KNOWLEDGE, PERCEPTION AND USAGE OF FUNCTIONAL
FOODS AMONG GHANAIS: A CASE STUDY IN THE
GREATER ACCRA REGION**

**THIS THESIS IS SUBMITTED TO THE
UNIVERSITY OF GHANA, LEGON**



BY

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**IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE
AWARD OF MPhil FOOD SCIENCE DEGREE**

JULY, 2014

DECLARATION

This is to certify that this thesis is the result of research undertaken by Asantewaa Afia Wiafe towards the award of the MPhil Food Science degree in the Department of Nutrition and Food Science, University of Ghana, under the supervision of Prof. Agnes S. Budu and Prof. Firibu K. Saalia. All references made to other people's work have been duly acknowledged.

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DEDICATION

This thesis is dedicated to the Lord Almighty who has brought me out of nowhere and has made me a better person now and also to my dad; Mr. Kwasi Wiafe Akenteng for his unending support for my education to date. God bless you for your effort.



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I am sincerely grateful to the Lord God almighty for his favour, grace and blessings upon my life especially during these periods of my studies. “I will enter His gate with thanksgiving in my heart all the time”.

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TABLE OF CONTENTS

DECLARATION	i
DEDICATION	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	v
LIST OF TABLES	x
LIST OF FIGURES	xi
LIST OF PLATES	xii
LIST OF ABBREVIATIONS	xiii
ABSTRACT	xiv
CHAPTER 1	1
1:0 INTRODUCTION	1
1.1 Background	1
1.2 Rationale of study.....	4
1.3 Objectives and Aims of Study.....	4
1.3.1 Main objective	4
1.3.2 Specific objectives	4
CHAPTER 2	6
2:0 LITERATURE REVIEW	6
2.1 Food Consumption Trend.....	6
2.2 What are Functional Foods?	7
2.3 Categories and characteristics of functional foods.....	10
2.4 History of functional foods.....	12
2.5 Functional foods, general wellbeing and health	12
2.6 Consumer and Functional Foods	15
2.6.1 Consumer awareness, perception and beliefs of functional foods.....	15
2.6.3 Knowledge and attitude of consumers towards functional foods	16
2.6.4 Consumer preference and willingness to use functional food; determinants and impeders.....	17
2.7 Influence of socio- demography and urbanization on the use of functional foods ...	18
2.8 Functional food claims and nutrients or dietary supplement.....	20

2.9 Bioactive Compounds / Functional Components of Functional Foods.....	22
2.9.1 What are bioactive compounds in foods?	22
2.9.2 Bioactive compounds in foods: spatial distribution, chemistry, physiology, analysis and importance to the body.....	24
2.9.2.1 Polyphenolic compounds	24
2.9.2.1.1 Flavanoids	25
2.9.2.1.2 Tannins.....	26
2.9.2.1.3 Phenolic acids.....	27
2.9.2.1.4 Stilbenes and lignans	27
2.9.2.2 Ascorbic acid/ Vitamin C	28
2.9.2.4 Antioxidants in food	31
CHAPTER 3	34
3:0 MATERIALS AND METHODS.....	34
3.1. Study design	34
3.2. Consumer survey	34
3.2.1. Study area and justification	34
3.2.1.1. Why the selection of a Church, Institution and Hospital	35
3.2.1.2 Why the peri-urban setting	35
3.2.2. Sample Size, Procedure and Inclusion Criteria	35
3.2.3. Data Collection and Quality Assurance.....	36
3.2.3.1. Interviews.....	36
3.2.3.2. Ethical consideration.....	37
3.3. Chemical analysis.....	38
3.3.1 Sample Selection.....	38
3.3.1.1 Cocoyam leaves (<i>Xanthosoma plant</i>)	38
3.3.1.2 Watermelon (<i>Citrullus lanatus var. Lanatus</i>)	39
3.3.1.3 Prekese (<i>Tetrapleura tetraptera</i>).....	40
3.3.1.4 Sweet basil (<i>Ocimum basilicum</i>).....	40
3.3.1.5 Black (African) velvet tamarind (<i>Dialium guineense Wild</i>)	41
3.3.2 Sample Collection, Preparation and Extraction.....	41
3.3.2.1 Sample collection.....	41
3.3.2.2 Sample preparation and extraction	41
3.3.2.2.1 Petroleum ether extraction of samples	41

3.3.2.2.2 <i>Methanol extraction</i>	42
3.3.3 Total Phenolic Content Determination	42
3.3.4 Ascorbic Acid Determination (AOAC Method 1990).....	43
3.3.5.1 <i>Sample Preparation</i>	43
3.3.5.2 <i>Standard Preparation</i>	43
3.3.5. 3 <i>Titration</i>	43
3.3.5 Total Tannins Determination	44
3.3.6 Antioxidant Activity Determination	45
3.3.7 Total Carotenoids Determination.....	45
3.3.8 Statistical Analysis.....	46
CHAPTER 4	47
4:0 RESULTS AND DISCUSSION	47
4.1 Introduction	47
4.2 Consumer Survey on Functional Foods among Urban and Peri- Urban Communities in the Greater Accra Region.....	47
4.2.1 Consumer background characteristics	47
4.2.2 Knowledge of FFDs.....	51
4.2.2.1 Awareness of FFDs.....	51
4.2.2.2 Knowledge on FFDs categories	52
4.2.2.3 Knowledge on medicinal components of FFDs.....	54
4.2.3 Beliefs and perceptions and their effect on FFDs choice in relation to health and general wellbeing.....	57
4.2.3.1 Effect of Beliefs and Perception on Food Choices	60
4.2.4 Source of Information by Consumers	61
4.2.4.1 Level of Trust in Information Source	62
4.2.5. Prevalence of Disease Condition of Consumer or Family/ Household Member	64
4.2.6 Determinants and impeters to the use of FFDs.....	67
4.2.6.1 Fears and Challenges with the Use of FFDs.....	67
4.2.6.2 Factors Influencing FFD Choice and Willingness of Consumers to Use FFDs	70
4.2.7 Nutrients Supplements Use.....	72
4.2.8 Associations between Specific Variables and FFDs.....	74

4.2.8.1 Association between Gender, Age & Level of Education and Consumers Awareness and Willingness to Try or Pay Extra Money for FFDs	74
4.2.8.2 Association between consumer information source, willingness to try FFDs and frequency of usage of the FFDs	76
4.2.8.3 Association between disease condition awareness and willingness to try FFDs	79
4.2.8.4 Association between disease condition and factors influencing FFDs choice	80
4.2.8.5 Association between Disease condition and frequency of usage of FFDs	81
4.2.8.6 Association between nutrient supplement use and the frequency of usage of FFDs.....	82
4.2.9 Specific Food Commodities Perceived To have nutraceutical properties	83
4.2.9.1 The top ten foods perceived to have nutraceutical properties	83
4.2.9.3 Fruits perceived to have Nutraceutical Properties	85
4.2.9.5 Vegetables Perceived to have Nutraceutical Properties	87
4.2.9. 6 Drinks Perceived to have Nutraceutical Properties	88
4.2.9.7 Natural spices Perceived to have Nutraceutical Properties	89
4.2.9.8 Cereals, Legumes, Nut and Seed Perceived to have Nutraceutical Properties	90
4.2.9.8 Sea Foods and Dairy Products Perceived to have Nutraceutical Properties....	91
4.2.9.9 Other food commodities Perceived to have Nutraceutical Properties	92
4.2.9.10: The top ten (10) FFD and the perceived health benefits by consumers	94
4. 3 Chemical analysis of bioactive Compounds in Selected FFDs	96
4.3.1 Total Polyphenols, Carotenoids, Tannins and Ascorbic Acid Content of Selected FFDs.....	96
CHAPTER 5	102
5:0 CONCLUSION AND RECOMMENDATION.....	102
5.1Conclusion.....	102
5.2 Limitations of the study.....	103
5.3 Recommendation.....	103
REFERENCES.....	105
APPENDICES	119
APPENDIX 1: INFORMED CONSENT FORM	119
APPENDIX 2: CONSUMER SURVEY QUESTIONNAIRE.....	122
APPENDIX 3: PRACTICES AND COMMENTS OF SOME CONSUMERS ON THE USE OF FFDs.....	127

APPENDIX 4: SAMPLE CALCULATION FOR LABOLATORY ANALYSIS USING COCOYAM LEAVES (KONTOMIRE).	128
APPENDIX 5: ANOVA OUTPUT FOR LABORATORY ANALYSIS	132



LIST OF TABLES

Table 3.1 Sample size distribution of participants across the two study locations.	36
Table 4.1 Socio-demographic characteristics of consumers by location (N=360)	48
Table 4.2 Knowledge of FFDS categories by consumers (N=360)	53
Table 4.3 Knowledge of FFDS components and who should use FFDS (N=360)	55
Table 4.4 Beliefs and Perceptions about Foods (N=360)	58
Table 4.5 Consumer Source of Information about FFDS (N=360)	61
Table 4.6 Prevalence of Disease Condition of Consumer or Family/ Household Member (N=360)	65
Table 4.7 Fears and challenges about the use of FFDS and Reasons (N=360)	68
Table 4.8 Factors influencing FFD choice and willingness of consumers to use FFDS (N=360)	70
Table 4.9 Nutrients Supplement Use and Reasons	72
Table 4.10 Relationship between Gender, Age and Level of Education and Awareness, Willingness to Try and Willingness to try FFDS	75
Table 4.11 Relationship between information source, willingness to try and frequency of usage of FFDS	78
Table 4.12 Relation between disease condition, awareness and willingness to try FFDS	79
Table 4.13 Relationship between Disease condition and Factors influencing FFDS	80
Table 4.14 Relationship between Disease condition and usage of FFDS	81
Table 4.15 Relation between Nutrient supplement and FFDS usage	83
Table 4.16 Perceived health benefit of the first ten (10) FFDS by Consumers	95
Table 4.17 Mean levels of Bioactive Compounds for Selected FFDS	96
Table 4.18 Antioxidant activity (%) of selected FFDS	97

LIST OF FIGURES

Figure 2. 1: Number of research reports dealing with nutraceutical or functional foods published in the period 1989–2009. Adopted from Bernal <i>et al.</i> , (2011).	10
Figure 2. 2: Structure of some polyphenols: Source Landete (2013)	26
Figure 2. 3: A, Structure of some common dietary carotenoids; Source Jomova and Valko (2013), B: Role of carotenoids in the prevention of chronic diseases; Source Rao and Rao, (2007).	30
Figure 4. 1: Awareness of FFDs	51
Figure 4. 2 Effect of beliefs and perceptions on food choices by location	60
Figure 4. 3 Level of Trust in Information Source by Consumers	63
Figure 4. 4: Strategies and food commodities used to manage disease conditions by consumers.....	67
Figure 4. 5: Frequency (%) of the top ten (10) perceived FFDs	83
Figure 4. 6: Frequency of usage of the top ten (10) FFDs	84
Figure 4. 7: Fruits perceived as FFD.....	86
Figure 4. 8: Herbs perceived to as FFD	87
Figure 4. 9: Vegetables perceived as FFD	88
Figure 4. 10: Drinks perceived as FFDs.....	89
Figure 4. 11: Natural spice Perceived as FFD.....	90
Figure 4.12: Cereals, Legumes, nut and seed perceived as FFD	91
Figure 4.13: Sea foods and Dairy and perceived as FFD.....	92
Figure: 4.14: Other Food commodities perceived as FFD.....	93

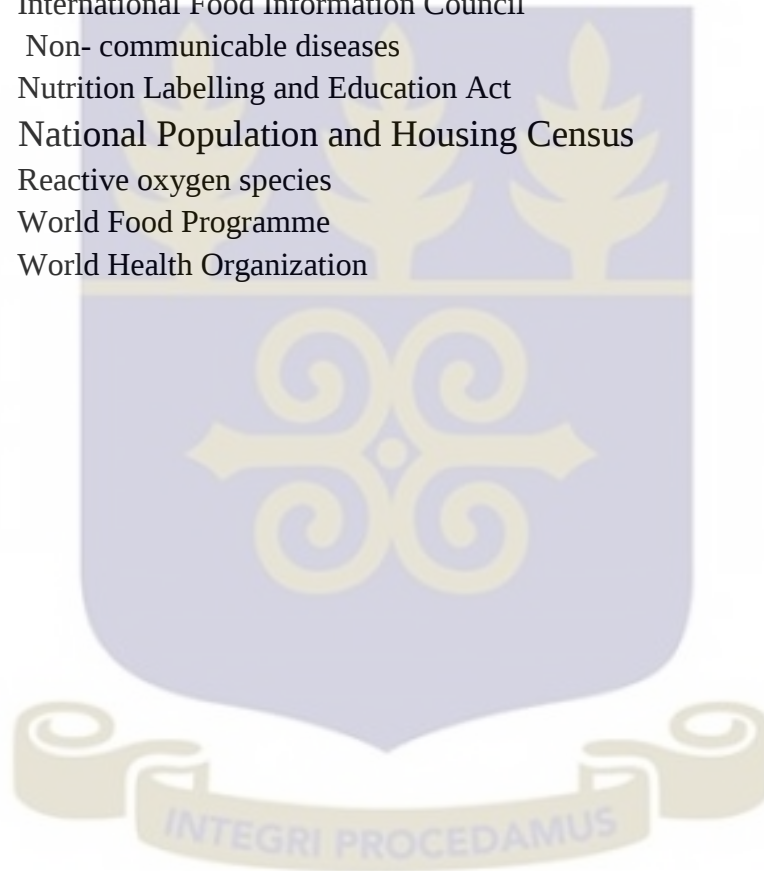
LIST OF PLATES

Plate 3. 1 Cocoyam plant and Leave (<i>Xanthosoma plant</i>).....	39
Plate 3. 2 Watermelon (<i>Citrullus lanatus</i> var. <i>lanatus</i>)	39
Plate 3. 3 Prekese (<i>Tetrapleura tetraptera</i>).....	40
Plate 3. 4 Sweet basil (<i>Ocimum basilicum</i>).....	40
Plate 3. 5 Black (African) velvet tamarind (<i>Dialium guineense</i> Wild).....	41



LIST OF ABBREVIATIONS

ADA	American Dietetic Association
AMA	American Heart Association
CDCP	Centre for Disease Control and Prevention
CVD	Cardiovascular diseases
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration (US)
FFDs	Functional foods
GIT	Gastrointestinal Track
IFIC	International Food Information Council
NCDs	Non- communicable diseases
NLEA	Nutrition Labelling and Education Act
NPHC	National Population and Housing Census
ROS	Reactive oxygen species
WFP	World Food Programme
WHO	World Health Organization



ABSTRACT

Functional foods (FFDs) are defined as foods or dietary components that may provide health benefits beyond basic nutrition. Acceptance and the willingness to choose a FFD are dependent on several factors including the consumer's attitude, knowledge and motivation, health claim, sensory and non sensory attributes and socio demographic variables. This study sought to assess the knowledge, perception and usage of functional foods among Ghanaian consumers and the nutraceutical properties of selected ones: using Greater Accra Region as a case study.

The study was conducted in two parts; consumer survey on functional foods and chemical analysis on selected foods perceived to have nutraceutical properties. The consumer survey was cross sectional; conducted at two different settings; urban and peri- urban settings in the Greater Accra region of Ghana using a semi structured questionnaire. The sample size consisted of approximately 360 consumers; 180 each of urban and peri- urban dwellers. Samples were selected for the chemical analysis after food commodities perceived by consumers to have nutraceutical properties were analyzed for their extent to which consumers perceive to be functional using their frequencies of distribution. *Xanthosoma plant*, (*Citrullus lanatus* var. *lanatus*), (*Tetrapleura tetraptera*), (*Ocimum basilicum*) and (*Dialium guineense* Wild) were selected. The chemical analyses conducted were; total polyphenols, total carotenoids, ascorbic acid, tannins and antioxidant activity. Cross-tabulations procedures were used to compare categorical variables among the two locations and the association between variables. One way analysis of variance was employed to determine differences in the means of analytes among samples. Significance levels among variables were set at $p < 0.05$.

Results showed that awareness of functional foods was high among both urban and peri-urban respondents (95% and 96%) respectively. Most respondents did not know any of the nutraceutical components of the foods perceived to have nutraceutical properties (76.7%). Most respondents both urban and peri-urban communities shared the belief and perception that certain foods are not good for one's health. The media was the most frequent source of information by both urban and peri-urban respondents. High blood pressure and diabetes were the most prevalent disease conditions among respondents and were significantly different among the two locations <0.001 and 0.04 respectively. A perception of health benefit was the highest factor influencing FFD choice (90.3%). Willingness to pay extra for a functional food was significantly associated with gender, age and level of education of consumers ($p < 0.05$). Information on FFDs from "family and friends", "media", "book magazines and school" were significantly associated with consumers willingness to try FFDs ($p < 0.05$). There were no significant association between the use of nutrient supplement and the frequency of use of FFDs ($p=0.386$). Fruits and vegetables were the most perceived FFDs by respondents. Bioactive/ nutraceutical compounds were present in all foods analysed. Basil had the highest polyphenols content (86.15mgGAE/g). Total carotenoids ranged from (32.21- 0.302) mg/100g of the samples analyzed. Watermelon had the highest ascorbic acid content (83.78mg/100ml) while total tannins content was highest in "*Xanthosoma plant*" (0.137mgTAE/g).

Functional foods contain components which may present a better and cheaper alternative for improving health and general wellbeing of consumers. Their usage needs to be encouraged.

CHAPTER 1

1:0 INTRODUCTION

1.1 Background

In recent years, there is a new diet health paradigm evolving worldwide which places more emphasis on the health enhancing aspects of diet. Consumers' demand in the last decades regarding food production has also changed considerably. Currently consumers demand more natural and less processed health promoting foods thus the inception of the concept of functional foods. Functional foods are known to play important role in reducing health risks and improving the health of consumers compared to conventional food commodities. Functional foods have been defined by the International Food Information Council (IFIC) (2007) as foods or dietary components that may provide a health benefit beyond basic nutrition. Frewer *et al.* (2003) also defined functional foods and products as providing an added health benefit over and above the food's or the food product's traditional nutritional value.

Annunziata and Vecchio (2011) reported that functional foods represent one of the most interesting areas of research and innovation in the food industries and has become one of the chief factors driving the development of new products. The functional food market was found to have recorded an annual growth rate ranging from 15% to 20% at the end of the 1990s and continued to increase exponentially at the end of 2009 (Hilliam, 2000; Bernal *et al.*, 2011). The benefits of functional foods have been so publicized through research that, consumers now believe that foods contribute directly to their health (Young, 2000; Mollet and Rowland, 2002). Thus, today, foods are not intended to only satisfy hunger and to provide necessary nutrients for humans but also to prevent nutrition-related

diseases and improve physical and mental well-being (Menrad, 2003; Roberfroid, 2000b). The increasing demand for functional foods can be explained by the increasing cost of healthcare, the steady increase in life expectancy and the desire of older people for improved quality of their later years in life (Sirò *et al.*, 2008). Carrillo *et al.* (2013) similarly found an association between satisfying consumers' demands for healthy foods and with the increasing number of functional foods and products on the market.

The positive health effect of a functional food may include not only for the maintenance of health or wellbeing, or a reduction in the risk of suffering a given illness (Perez-A´lvarez *et al.*, 2003) but for the management or control of diseases such as diabetes, hypertension, hyper lipidemia, constipation, certain cancers, obesity, inflammation among other chronic diseases (Gu-Chen *et al.*, 2013). Another advantage of functional foods and products are that most are derived from existing traditional foods by adding ingredients or modifying the composition and are mostly natural (P´erez-A´ lvarez *et al.*, 2003; Martijn and Nicole, 2004;).

Thanh-Sang and Se-Kwon (2013), explains that the capacity of some plant-derived functional foods to reduce the risk of chronic diseases has been associated partly to the occurrence of secondary metabolites that have been shown to exert a wide range of biological activities. The bioactive ingredients that confer the potency of functional foods include: phyto-chemicals such as phenolic acids, flavones, phytic acid, flavanoids, coumarins and terpenes; antioxidant (lycopene and β -carotene), vitamins and mineral among others. In general, these metabolites have low potency as bioactive compounds when compared to pharmaceutical drugs; its advantage is that, since they are ingested regularly and in significant amounts as part of the diet, they may have a noticeable long-term physiological effect (Espí´n *et al.*, 2007). Particularly, these products are, safe, economical and have fewer side effects than many drugs routinely prescribed in the

treatment of certain symptoms (Raskin *et al.*, 2002). A number of functional foods according to Thanh-Sang and Se-Kwon (2013) are found from natural sources and categorized under various food and food product groups including cereals, fruits and vegetables, spices, herbs, meat and fish, legumes, tea and drinks, spread among other foods.

There is the need for consumers to be convinced on considering substituting conventional with functional foods if the latter are perceived as comparatively healthy. Acceptance of functional food and products are determined by a multitude of factors though the consumer continues to be the focal point. These factors includes primary health concerns, consumers' familiarity with the functional foods concepts and with the functional ingredients, the nature of the carrier product, the communication mode of the health effect, mode of consumption among others (Verbeke, 2005; Sirò *et al.*, 2008 ; Annunziata and Vecchio, 2011). The willingness and choice of functional foods on the other hand have been found to be dependent on other factors other than the consumer and may include health claim, sensory (such as appearance, taste, texture) and non sensory attributes (price and brand), convenience and packaging (Annunziata and Vecchio, 2013). Attitude, knowledge and motivation have also been described by Herath *et al.* (2008) as some of the factors affecting the acceptance and willingness to try functional foods. A study by Ares and Ga'mbaro (2007) also found out that, the effect of different food carriers and enrichment, socio-demographic variables such as age, gender and level of education and motives underlying food choice all affect the perception of healthiness and willingness of consumers to try and accept functional foods. Several other studies for instance have reported that increasing nutritional knowledge was associated with higher intake of fruits and vegetables which are perceived to have health benefits (Patterson *et al.*, 1997; Wardle *et al.*, 2000).

1.2 Rationale of study

In Ghana, the concept of functional foods or bioactive components of foods has not been clearly defined to the public since the concept of Functional Foods itself is generally new. However, personal communication and some preliminary studies revealed that, consumers seem to have knowledge of some ‘medicinal foods’ and their perceived positive effects on health (Budu *et al.*, 2011). A lot of food commodities are known and consumed in Ghana ranging from drinks, snacks, fruits and vegetables, natural spices and processed food products, which are perceived to impart health benefits. There is the need to establish the knowledge and perception of consumers, their source of information, the extent of usage, as well as the active ingredients imparting the supposed health benefit on these functional foods.

This would help add on to the knowledge and consumption of these functional foods by the Ghanaian populace and inform stakeholders to educate Ghanaians on the possible health benefit of these foods to increase their consumption.

1.3 Objectives and Aims of Study

1.3.1 Main objective

The objective of the study is to assess the knowledge, perception and usage of functional foods (FFDs) among Ghanaian consumers and the nutraceutical properties of selected functional foods using Greater Accra Region as a case study.

1.3.2 Specific objectives

- ❖ To assess consumers’ knowledge, beliefs and perceptions of functional foods in Ghana, using urban and a peri-urban communities in the Greater Accra Region.
- ❖ To assess the determinants and impeters to the use of functional foods by consumers in the Greater Accra Region

- ❖ To determine the association between socio- demographic variables, health status, information source, factors influencing functional food choices and knowledge, usage and willingness to patronize functional foods among consumers in the Greater Accra region.
- ❖ To assess the foods perceived to have nutraceutical properties among Ghanaian food commodities by consumers in the Greater Accra region.
- ❖ To determine the nutraceutical properties of some selected functional foods stated by consumers.



CHAPTER 2

2:0 LITERATURE REVIEW

2.1 Food Consumption Trend

Food is eaten to perform three basic functions; primarily for the provision of nutrients, secondly for the sensory functions (taste, appearance and colour among others) and lastly for its physiological role in the body (Yamada *et al.*, 2008). Functional foods are consumed to play the third role of food in the body. Roberfroid (2000a) also explains that the primary role of diet is to provide enough nutrients to meet metabolic requirements while giving the consumer a feeling of satisfaction and well-being. However recent knowledge supports the hypothesis that beyond meeting nutritional needs, diet may modulate various functions in the body as well as play beneficial or detrimental roles in some diseases thus the emergence of functional foods. According to Kearney (2010), the main drivers and consequences of food consumption changes over the years include; socio economic, urbanization, consumers and health, diseases of association and affluence (nutrition –related NCDs) among others.

Current food consumption patterns according to Fischer (2006), partly results from a number of factors which include higher value-added products with greater convenience attributes, a greater presence and diversity of ethnic foods, heightened consumer concerns for nutrition, safety, and health, and growing sensitivity to environmental and social externalities such as production technologies, distribution systems, ecological sustainability, and animal welfare. Foods, especially functional food consumption is increasing in almost all industrialized countries. Consumer health awareness continues to grow with the increasing availability of health information going hand in hand with the

ageing of populations and increased risk for lifestyle diseases. The recent increased interest in functional foods and drinks according to Frewer *et al.* (2003) has been fuelled by a desire for convenience, as well as health. It is estimated that the development of functional foods will continue to grow in industrialized countries, due to increasing life expectancy, higher prevalence of non-communicable diseases, increasing healthcare costs and the acceptance of the strong link between diet and health. However it is worth recognizing that consumers remain the focus of the acceptance and willingness to try these new foods. Success in the functional food market is increasingly dependent on establishing a relationship of trust with the consumers (Frewer *et al.*, 2003).

2.2 What are Functional Foods?

In most countries there is no legislative definition of the term functional foods, thus drawing a border line between conventional and functional foods is challenging even for nutrition and food experts (Palou *et al.*, 2003; Mark-Herbert, 2004; Niva, 2007). An explorative analysis reported by Annumziata and Vecchio (2011a) revealed that even consumers themselves in some European countries were confused due to the ambiguity of what functional foods and products were, despite they having to recognize the close link between diet and health and a high level of interest in the nutritional and health aspects of their food choices. Hilliam (2000) also found similar findings where, up to 75% of the consumers had not even heard of the term “functional food”. However, terms like “nutraceuticals,” “pharma foods,” “designer foods,” “nutritional foods,” “medical foods” or “super foods” have been used as well to describe the term functional food by consumers (Childs and Poryzees, 1998).

To date, a number of national authorities, academic bodies and the industry have proposed definitions for functional foods ranging from the very simple to the more complex ones. Basically, “Foods that may provide health benefits beyond basic nutrition” or “Food

similar in appearance to conventional food that is intended to be consumed as part of a normal diet, but has been modified to sub-serve physiological roles beyond the provision of simple nutrient requirements” are good examples for the two approaches (Bech-Larsen and Grunert, 2003). The International Food Information Council (IFIC); (2007) also defines functional foods as “foods or dietary components that may provide a health benefit beyond basic nutrition”. Better still a functional food is a branded food which claims explicitly or implicitly to improve health or well-being (Martijn and Nicole, 2004).

Functional foods are foods with nutraceutical properties. Thus the term “functional foods” are used interchangeably with the term “nutraceutical”. However, “nutraceuticals” according to Shahidi, (2009) are foods or compounds derived from foods, but are used in the medicinal form of pills, capsules, potions and liquids and again render demonstrated physiological benefits. The American Dietetic Association also added that “nutraceutical” have recently been recognized as “those diet supplements that deliver a concentrated form of a presumed bioactive agent from a food, presented in a non food matrix, and used to enhance health in dosages that exceed those that could be obtained from normal food”. It could be said that functional foods are clearly under the broad topic of nutraceutical. There are also natural health products which does not only include nutraceutical, but encompass herbal and other natural products for the attainment of health and wellbeing. According to Martijn and Nicole (2004), in some countries, functional foods and nutraceutical are used interchangeably; however, in all cases, the main focus is on improving health and reducing disease risk through, mainly, prevention.

Carrillo *et al.* (2013), explains that functional food was described by Margaret, (2002) as “a food that has been satisfactorily demonstrated to beneficially affect one or more target functions in the body beyond adequate nutritional effects in a way that is relevant to either an improved state of health and well-being and/or to a reduction of the risk of disease”.

Functional foods may be categorised as either improving the general conditions of the body (for example pre- and probiotics), decreasing the risk of some diseases (example cholesterol-lowering products), and for curing some illnesses (Sirò *et al.*, 2008).

Many factors fuel interest in functional foods, such as rapid advances in science and technology, increasing healthcare costs, changes in food laws affecting label and product claims, an ageing population, and rising interest in attaining wellness through diet. It should be mentioned that not only food manufacturers, but also the pharmaceutical industry has become interested in this field (Sääksjärvi *et al.*, 2009). Bernal *et al.* (2011), in a review on functional food and nutraceutical described the rising interest in these fields of research and study as being an exponential growth over the last twenty years (Figure 2.1), thus contributing to a better and scientific understanding of this field of research and studies. Reports on functional food were however higher compared to that on nutraceuticals. According to Sirò *et al.* (2008), issues pertaining to these functional foods and their field of studies are not only of interest to food manufacturers but also to the pharmaceutical industry. The functional food market is one of the fastest growing food sectors, with a compound annual growth rate of 8.6% in the last 10 years (Euromonitor, 2010). Different demographical studies have again revealed that due to the rather expensive nature of medical service of the aging population, there is increased interest in functional foods and products and they are also on high demand by consumers (Mark-Herbert, 2004; Menrad, 2003; Side, 2006).

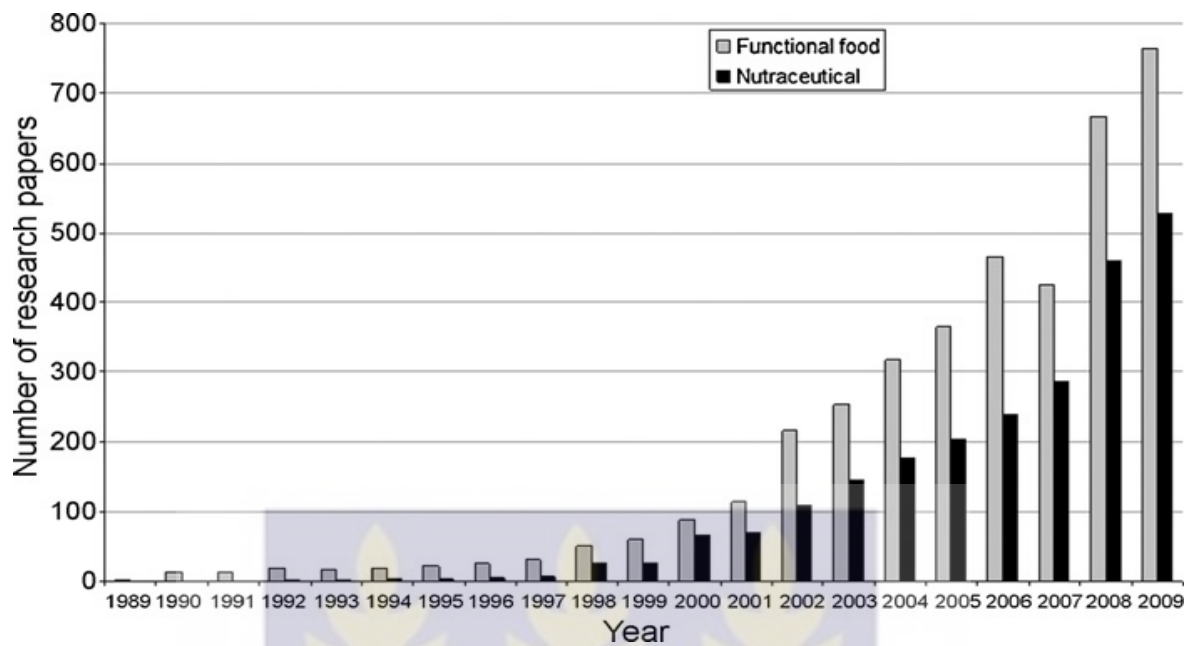


Figure 2. 1: Number of research reports dealing with nutraceutical or functional foods published in the period 1989–2009. (Adopted from Bernal *et al.*, 2011).

2.3 Categories and characteristics of functional foods

Food in one form or the other could be said to be functional depending on the reason behind its consumption. There are various functional foods among our diet. However Sääksjärvi *et al.*(2009), reported that drinks, chewing gum, spreads, dairy (milk, prebiotics and probiotics), fruit and vegetables, spices and cereal products are some product categories in which consumers all over the world have a wide array of functional foods to choose from. The IFIC (2007) found that fruits and vegetables were the top functional foods category identified by consumers during a survey on ‘Consumer Attitudes Toward Functional Foods/Foods for Health’ confirming that, the first thought that comes in mind when the term is mentioned is basically fruits and vegetables. Functional food however does not only include fruits and vegetables but other staple food crops, edible herbs as well as processed food products. According to Dhanvijay (2013), functional foods groups may include roots and tubers; (onion, garlic and carrots), fruits; (tomato, lemon and guava), green leafy vegetables; (all green leafy vegetables), legumes: (soybean, sprouts,

condiments and spices); and fermented or probiotic food; (curd, yoghurt and cheese) thus there exists not a single acceptable categorization of functional food.

Martijn and Nicole (2004) reported that, functional foods may include “those products created just so that they can be marketed using health claims”. Thus it is likely to find a functional food product marketed under a health claim such as “cholesterol free”, “good for the heart” among other health claims. A food may also be made functional to play beneficial role in the body (Hasler, 2000). Roberfroid (2000a) explained that a food may be made functional by any of the processes below;

- Eliminating a component known to cause or identified as causing a deleterious effect when consumed
- Increasing the concentration of a component naturally present in food to a point at which it will induce predicted effects (for example, fortification with a micronutrient to reach a daily intake).
- Adding a component which normally is not present in most foods; not necessarily functioning as a macronutrient or micronutrient but have been found through research to have some beneficial effects (for example, non-vitamin antioxidant or prebiotic fructans).
- Replacing a component, usually a macronutrient (example fats), whose intake is usually excessive and thus causes deleterious effects to the human system when consumed, with one for which beneficial effects have been shown (example chicory inulin such as Rafti cream).
- Increasing bioavailability or stability of a component known to produce a functional effect or to reduce the disease-risk potential of the food.

2.4 History of functional foods

History has it that the term “functional food” itself was first used in Japan, in the 1980s for food products fortified with special constituents that possess advantageous physiological effects (Hardy, 2000; Kwak and Jukes, 2001). The concept of functional food was first promoted in 1984 by Japanese scientists who studied the relationship between nutrition, sensory satisfaction, fortification and modulation of physiological systems. The Ministry of Health in Japan introduced rules for approval of a specific health-related food category called FOSHU (Food for Specified Health Uses) in 1991 which included the establishment of specific health claims for functional foods (Sirò *et al.*, 2008). Thus Japan is highly significant as the birthplace where the market of functional foods started. Hilliam, (2000) and Menrad, (2003) reported that between 1988 and 1998 more than 1700 functional food and products had been launched in Japan with an estimated turnover of around 14 billion US\$ in 1999. There is no doubt that the Japanese interest in functional foods has brought awareness for the need of such foods and products in places such as the Europe and the United States and gradually spreading across other parts of the world (Sirò *et al.*, 2008).

2.5 Functional foods, general wellbeing and health

Functional food and products according to Hearsman and Mellentin (2001) and Frewer *et al.* (2003) have been found to provide an added health benefit over and above their traditional counterparts especially their nutritional value. Today foods are not intended to only satisfy hunger and to provide necessary nutrients for humans but also to prevent nutrition-related diseases and improve physical and mental well-being of the consumers (Menrad, 2003; Roberfroid, 2000b). The main consumer motive for purchasing functional foods is the growing desire to use foods either to help prevent chronic illnesses such as cardiovascular disease, Alzheimer’s disease and osteoporosis, or to optimize health, for

example by increasing energy, boosting the immune system and generation of wellbeing. Consumers continue to have increased believe that foods contribute directly to their health (Mollet and Rowland, 2002; Young, 2000). According to the World Health Organization (WHO) 2004 reports, diet is widely sanctioned by the scientific community as a modifiable factor that could be used to restrain the escalating health care costs associated with non communicable degenerative diseases along with weight control and physical activities. According to Perkins-Veazie *et al.*, (2012), many countries have enormously been burdened health- wise with chronic diseases such as cancer, cardiovascular disease, obesity and diabetes.

The role of diet and nutrition as determinants of chronic diseases has been well recognized and established (CDCP, 2004). Chronic inflammation, which can include radical (pro-oxidant) formation, and cytokine production, is often an underlying cause of these diseases (WHO, 2004). Diet has been proposed to appear to play a large role in development and severity of these diseases, through generation of free radicals, up regulation of transcriptor molecules, and overproduction of cytokines (Kundu and Surh, 2008). Health costs and decreased quality of life associated with chronic diseases have driven interest in the use of healthy diet targeted for specific problems. Emerging results indicate that fruits and vegetables for instance can work at numerous levels, including prevention of lipid oxidation, squelching of free radicals, and altering hormonal release (Roberfroid, 2000a, 2000b; Kotilainen *et al.*, 2006). Arvanitoyannis and Houwelingen-Koukaliaroglou (2005) also added that the increasing demand on healthy foods can be explained by the increasing cost of healthcare, the steady increase in life expectancy, and the desire of older people for improved quality of their later years.

Fruits and vegetable, the most common functional food across the world also present an opportunity for the increase usage of food with health benefits. Fruits for instance contain glucose, fructose, sucrose and fiber, and are mostly relatively low in calories. In addition, fruits are important sources of at least eight additional nutrients, including vitamin C, folate, and potassium (which may help control blood pressure). Many vegetables provide only small amounts of sugars and/or starch and they all provide fiber. According to Roberfroid (2000a) and Hornick and Weiss (2011), vegetables are also important sources of 19 or more nutrients, including potassium, folate, and vitamins A and E and may provide antioxidant effect to the body. There is a belief that adults who increase their fruit and vegetable consumption in adequate quantities are associated with a decreased risk of chronic diseases as stroke and perhaps other cardiovascular diseases; (type 2 diabetes and cancers in certain sites) (Dhanvijay, 2013). Fruits and vegetables may also be useful in achieving and sustaining weight loss. A report by Hill and Peters (2002) also suggested that diet, for that matter functional foods clearly play an important role in the prevention, development and management of obesity and diabetes especially type 2 diabetes.

Spices also constitute an important part of human nutrition and have played a role in all cultures of the world. Viuda-Martos *et al.* (2010) reported on the role spices play to impart flavour and reduce the need for salt and fatty condiments, improve digestion, and provide the organism with extra antioxidants that prevent the appearance of physiological and metabolic alterations. Thus spices as a category of food also play functional roles in the body and are highly importance in the consumers' diet in the attainment of optimum health.

Taraxacum officinale commonly called “dandelion” for instance has been found to have a lot of medicinal and health benefit to the body including: prevention or curing liver diseases, such as hepatitis or jaundice; act as a tonic and gentle diuretic to purify the

blood, cleanse the system and dissolve kidney stones. Dandelion also improve gastro-intestinal health; assist in weight reduction; cleanse the skin and eliminate acne; improve bowel function, relieve both constipation and diarrhoea; prevent or lower high blood pressure; prevent or cure anemia among other benefits. Aside the numerous health benefits dandelion like many other functional foods have no negative side effects and selectively act on only the specific ailments (*Gail, 1989*).

2.6 Consumer and Functional Foods

2.6.1 Consumer awareness, perception and beliefs of functional foods

Several research has showed that the interest of consumers in functional foods continue to drive their acceptance in the system with respect to consumers health (*Van-Trijp and Vander-Lans, 2007*). The perceived health benefits and the belief in a functional food continue to drive their usage and may include to lower high blood cholesterol levels, high blood pressure, risk of diabetes and improve the body's immune and digestion systems (*Urala and Lähteenmäki , 2003*). These perceptions and beliefs are among the biggest health concerns by consumers when choosing a functional food. A study among young consumers on their willingness to use functional foods revealed that the expected or perceived health benefit of the food were one of the strongest factors influencing their use among other factors such as the need for the functional food, the confidence in the functional food and the safety of it (*Jeżewska-Zychowicz, 2009*). For predicting choices of functional food according to *Urala and Lähteenmäki (2003)*, personal attitudes and beliefs of consumers are also important. Acceptance of FFDs is determined by a multitude of factors such as primary health concerns, consumers' familiarity with the functional food and ingredients; awareness, the nature of the carrier product, the communication mode of the health effect among others (*Annunziata and Vecchio, 2011b*).

2.6.3 Knowledge and attitude of consumers towards functional foods

Consumers can only be expected to choose functional over conventional foods if they (i) know enough about both functional and conventional food products (ii) believe that the differences between them justify the higher prices and (iii) that the health claims will benefit them without risk. In a global survey polling of over 21,100 respondents from regular internet users in 38 markets across Europe, Asia Pacific, North America, Latin America, and in South Africa, ACNielsen (2005) found that consumers' knowledge and awareness of different healthy foods including functional foods was remarkably low. Menrad (2003) and Verbeke (2005) also reported similar findings. Knowledge about the health claims and benefits of functional foods continue to be a key driven force to their continual patronage and usage. As Wansink *et al.* (2005) points out: "to consume a functional food, people need to know 'what' and 'why'". Thus without specialised knowledge, a consumer is likely to only buy functional foods occasionally, reflecting random fluctuations in his or her buying behaviour rather than a consistent preference towards functional foods. Respondents' in the ACNielsen's study's on attitudes toward functional foods were however positive and was expressed in various criteria including ; interest in trying functional foods, willingness to pay extra for functional foods and trying more new foods.

Sääksjärvi *et al.* (2009) again reported that consumers who are knowledgeable about food and nutrition are concerned about their own health and perceive that diet influences health thus more likely to consume healthy foods. This proves the need for individuals and the society to learn more about the consumer and functional foods to help promote health, welfare and general wellbeing of all. There are also some conflicts with the clear knowledge and understanding of what a functional food is by consumers. Urala *et al.* (2011) reported that some functional food product and categories such as a cholesterol-

lowering spread was recognized by small portion respondents as being a functional food product. Consumer knowledge thus plays a key role in the frequent usage of functional foods and products.

2.6.4 Consumer preference and willingness to use functional food; determinants and impeters

It is still unclear how strongly the health benefits and knowledge drive functional food purchases in real life as consumers are sometimes not ready to compromise taste for health. Hedonic properties such as taste, flavour, texture, mouth feel among others according to Tuorila *et al.*, (2002) and Verbeke, (2005) strongly drive the choices of functional foods. However, sometimes mentioning the positive health consequence alone even motivates the consumer (Urala and L  hteenm  ki, 2003, Wansink *et al.*, 2005). Reviews concerning studies on the acceptance and use of functional foods revealed that, consumer acceptance of functional foods are more or less conditional, with one of the main conditions for acceptance pertaining to taste, besides trustworthiness of health claims (Verbeke, 2005). Taste also plays the primary role as a factor that directs consumers' food choices in general (Fisher, 2006). There also exist a high and significant positive correlation between health benefit belief and acceptance of functional foods, with respect to tasting either good or bad. Urala and L  hteenm  ki (2004) however indicated that some products may have such a strong health claim that consumers are still ready to compromise on taste.

Another challenge for functional food marketers is related to the price premium of about 30–50% that functional foods tend to imply. According to S   ksj  rvi *et al.* (2009), increased awareness and knowledge on functional foods continue to justify the payment of higher price by consumers. A major reason for not buying functional foods that came to light in ACNielsen's (2005) study was that, functional food benefits are poorly understood

and therefore do not justify a price premium. Across all product categories, functional foods tend to be significantly more expensive than the corresponding conventional products (Sääksjärvi *et al.*, 2009).

In general, it has been established that recognized institutions, associations and experts are the most trusted sources of information for functional food purchasing and consequently its usage. Food producers, food retailers and media together were considered a less trustworthy source of information on functional foods by consumers (Urala *et al.*, 2011). Communication of the health benefits should thus lean on sound scientific evidence and disseminated by trustworthy individuals and associations. The medium of communication of the benefits of functional foods should also be considered as it represents a great source of motivation in their usage (European Commission Report on FFDs, 2010).

A lot of researchers conclusively reported that economic factors such as price, availability, and income influence the actual consumption and the use of foods in general; what and how much is chosen. However, preference is always a priority to the consumers. For instance one might “prefer” steak to bread but still eat ‘use’ more bread because of its price or availability (Fischer, 2006).

2.7 Influence of socio- demography and urbanization on the use of functional foods

A quantitative study in the US during 1992–1996 by Childs (1997) identified for instance the US functional food consumer as being female, well educated, higher income class and in a broad 35–55 age group. IFIC (2000) similarly reported that women, college graduates and consumers aged 45–74 are most likely to have adopted functional foods in their diets. Several studies conclusively reported that a higher proportion of consumers aged 55 and above and college educated were found to be functional food users and its usage is

affected by gender, age and educational level of the consumer (de Jong *et al.*, 2004; Gilbert 1997; IFIC (2007) also found that. Verbeke (2005) reported that a survey conducted in 2001 and 2004 both revealed that female respondents reported a significantly higher perceived importance of food for health as compared to men, which is consistent with literature reporting a stronger health-orientation for food among females. The 2001 findings again revealed that women and elderly were more ready to compromise on the taste of functional foods than men and younger consumers. In general, women have been shown to be more reflective about food and health issues and they seem to have more moral and ecological misgivings about eating certain foods than men, who are more confident and demonstrate a rather uncritical and traditional view of eating (Gilbert, 1997; Beardsworth *et al.*, 2002;; Verbeke and Vackier, 2004). Women according to Ares and Ga'mbaro (2007) have a more positive attitude towards functional foods than men. The presence of young children in the household has been reported to be a very pertinent socio-demographic factor that affects the choice of healthy and fortified foods in general by household food shoppers (Verbeke, 2005). A study among Uruguayans also revealed that women are responsible for selecting what to eat and preparing meals at home while men and young people do not care much for this factor, as they usually eat what women prepare thus the choice of healthy foods and for that matter a functional food greatly depends on the women (Ares and Ga'mbaro, 2007).

Differences in health or ill-health mostly depicted between rural and urban dwellers are related to differences in environmental factors, especially diet. However, it must be kept in mind that patterns of health and disease are determined not only by diet, but by genetic, and by non-dietary factors (Walker, 1995). The experience with relative's loss of good health (disease conditions) by consumers and associated economic and social consequences have been reported to act as an incentive to adopt disease preventive food

habits (Childs, 1997); prevention is a major motivation of functional food use (Ajewole and Omonona (2006). The World Food Program (WFP) (2002) reported that urbanization is perhaps the most dominant demographic process in recent decades across Africa which affects greatly livelihood and lifestyle.

High educational level has been found among urban dwellers than non-urban dwellers, thus Ajewole and Omonona (2006) again reported a higher percentage of the rural household heads have not had formal education or have only a primary education while the urban household heads have a higher percentage with secondary and tertiary education thus all affecting their household food choices in general. Household size, per capita household food expenditure and access of different food groups including functional food and products (enriched, modified or fortified) all followed a similar pattern as the differences in educational attainment among consumers especially the house heads (Lane *et al.*, 2012). The urban area conclusively could be said to have a high socio- economic status compared to the non- urban or rural areas in terms of why, how and what is chosen and consumed.

2.8 Functional food claims and nutrients or dietary supplement

Consumer's prior access to information on functional foods can help to make good purchasing decisions, and the manufacturers can use the information to promote sales by emphasizing the health benefits of their products. Labelling and advertising should thus be clear and correct to avoid any misunderstanding or exaggeration by manufacturers (Ji-Yeon *et al.*, 2010). There is thus the need for regulations on the use of health claims on foods and functional food products and sometimes even backed by national acts as in the case of US and Japan. In the United State for instance, there are currently three categories of claims that food and dietary supplement manufacturers can use on labels to communicate health information to consumers. These are the nutrient content claims,

structure or function claims; and health claims. Health claim which usually covers the functionality of the food or products according to the Nutrition Labelling and Education Act (NLEA) of 1990 is defined as statements that describe a relationship between a food substance and a disease or other health-related condition and require the authorization by the FDA before being used on a functional food product.

Health claims on food products, including functional foods, should be based on the significant scientific agreement standard of evidence and the American Dietetic Association (ADA) supports label claims based on such strong scientific substantiation. The substantiation of health claim for a functional food product or ingredients by the regulatory bodies include provision of authentic safety and risk assessment data, functional ingredients whether permitted to use, history of safe use, estimates of intake, toxicity or safety information and nutritional information. The regulation of the health claims by recognised institutions all aim to providing information to the consumer and protecting them from unsafe foods and products.

The Dietary Supplement Health and Education Act of 1994 specifically defines a dietary supplement as “a special category of food, legally classified as foods, but not considered conventional foods which is consumed in a diet such as a fruit or an entire meal”. The American Dietetic Association (ADA) and the FDA provides a regulatory definition of dietary supplements as “a product (other than tobacco) that is intended to supplement the diet, which contains one or more of the following dietary ingredients- a vitamin, a mineral, a herb or other botanical, an amino acid, a dietary substance to supplement the diet by increasing the total daily intake, or a concentrate, metabolite, constituent, extract, or combinations of these ingredients; is ingested in pill, capsule, tablet, or liquid form; is not represented for use as a conventional food or as the sole item of a meal or diet; and is labelled as a “dietary supplement.”. Consumers tend to use most dietary supplement as the

name implies to augment and support their nutrient needs in achieving general wellbeing and longevity.

2.9 Bioactive Compounds / Functional Components of Functional Foods

2.9.1 What are bioactive compounds in foods?

Consumer increasing attention has in recent years been geared toward healthy foods and diet due to the presence of bioactive or functional components and chemicals (carotenoids, phenolic compounds, essential minerals, lipids and proteins) (Scalzoa *et al.*, 2005). These compounds are usually referred to as phytochemicals and they play diverse biological and physiological roles in the body: reducing the risk of aging, cardiovascular disease, cancer, inflammatory disease, skin disease, malaria, immune deficiency disease and other age-related degenerative diseases. Typically, bioactive compounds of plants are produced as secondary metabolites (Bernhoft, 2010). A simple definition of bioactive compounds in plants is: “secondary plant metabolites eliciting pharmacological or toxicological effects in human and animals and have no growth functions although may have survival functions” (Bernhoft, 2010). Unlike bioactive compounds, primary metabolites, such as carbohydrates, amino acids, proteins and lipids are needed for growth and development (Azmir *et al.*, 2013).

Pennington (2002) reported that at least 120 naturally occurring food commodities have been identified as containing functional or bioactive components. For instance the current shift in the consumption of fruits and vegetables is mainly due to the promotion of preventive health and the significant amount of some of these bioactive compounds in them: flavanoids, phenolic acids, tannins, stilbenes, carotenoids, antioxidant capacity among others. Lycopene, a bioactive pigment found in red- fleshed fruits and vegetables

especially tomatoes and watermelon has been found to be associated with prostate cancer prevention and cardiovascular health (Perkins-Veazie, 2012). Essential lipids with potential benefits for human health have been identified in several natural sources including cereals, fruits, animals, oils, plants, mushrooms among others (Bernal *et al*, 2011). It has also been proven that peanuts and tree nuts contain essential lipids and bioactive compounds and also elicit positive healthful effects.

The Adventist Health study (Fraser *et al.*, 1992) showed that subjects who consumed nuts more than four times a week experienced substantially fewer definite fatal coronary heart disease events and definite non-fatal myocardial infarctions; nuts in this case were defined as almonds, Brazil nuts, cashews, hazelnuts, macadamia nuts, pecans, pistachios, walnuts, and legume peanuts. It should however be noted that most of these bioactive components of foods especially flavanoids, antioxidants and phenolic acids may vary depending on environmental and genetic conditions (Ignat *et al.*, 2011). Flavanols, a class of flavanoids commonly found in fruits and vegetables vary greatly in content depending on the environmental factors such as growing conditions, climate, storage and cooking conditions (Ignat *et al.*, 2011). Scalzoa *et al.*, (2005) reported that total antioxidant capacity is strongly affected by the type of fruit (species and variety within species) as well as cultivation conditions of the plant (environmental and cultivation techniques). The study continue to reported that the interaction of these different factors in determining the antioxidant capacity of a specific fruit should be established to better characterize agronomic production and inform the consumer.

2.9.2 Bioactive compounds in foods: spatial distribution, chemistry, physiology, analysis and importance to the body

2.9.2.1 Polyphenolic compounds

Polyphenolic compounds are among the bioactive compounds that have a lot of health benefits in relation to antioxidants, anti-inflammatory, cardio protective, cancer, chemo preventive and neuro-protective properties (Landete, 2013). Polyphenols comprises a number and variety of molecules with polyphenol structures and they are characterized by the presence of more than one phenol unit or building block per molecule (Bravo, 1998). The amount and the type of ingested fats, the intake of dietary fibre and the consumption of antioxidant compounds including polyphenols have been correlated to various chronic degenerative diseases. All plant-based foods have phenols which affect their appearance, taste, odour as well as oxidative stability (Ignat *et al.*, 2011).

Polyphenols present in food can help limit the oxidative damage and acting directly on reactive oxygen species or by stimulating endogenous defence systems (Förstermann, 2008). This is made possible by the phenolic groups in polyphenols accepting an electron to form relatively stable phenoxyl radicals leading to the disrupting chain oxidation reactions in cellular components (Landete, 2013). Its efficiency as antioxidant compounds is greatly dependant on their chemical structure. According to Ignat *et al.*, (2011), more than 8000 polyphenolic compounds have been identified. Polyphenols can be classified into two major types: flavonoids and non-flavonoid phenolics. There are several methods for the quantification of total phenolic compounds in foods but the most commonly used one is the Folin-Ciocalteu method. This method is performed spectrophotometrically which is based on the reduction of a photowolframate –phophomolybdate (a molibdo-tungstate) complex by phenolics to blue reaction products using gallic acid as a standard (Porgali and

Buyuktuncel, 2012). This classical method measures the colour change associated with the reduction of the reagent induced by the phenols in the test sample (Bernal *et al.*, 2011).

2.9.2.1.1 Flavanoids

Flavanoids contribute to about half of the identified polyphenols so far. These are low molecular compounds consisting of fifteen carbon atoms arranged in C6-C3 configuration with two aromatic rings. There exist different kinds of flavanoids which includes; flavanols, flavones, flavanones, catechins, isoflavones, flavanonols and anthocyanidins. Flavones and flavanols are the most abundant in foods. Flavones include apigenin and luteolin; flavanols include quercetin, kaempferol, and myricetin with quercetin being the main flavonol in the human diet abundantly found in onions and tea. Catechins and epicatechins are on the other hand the principal components in all types of teas, thus sometimes they are called tea catechins. Fruits and berries, nuts, beans, barley, sorghum, curry, cinnamon, wine, and beers also have pro anthocyanidins widely present in them (Yang *et al.*, 2001; Arts and Hollman, 2005).

Flavanoids particularly from fruits, vegetables, nuts, seeds, and flowers, as well as in several beverages especially tea, deliver a complex mixture of polyphenols and phenolic acids to our gastrointestinal tract. Flavonoids according to Landete (2013), are among the most potent plant antioxidants because they possess one or more of the following structural elements involved in the antiradical activity: an *o*-diphenolic group (in ring B), a 2–3 double bond conjugated with the 4-oxo function, and hydroxyl groups in positions 3 and 5. It should also be noted that flavanoids like any other biological compounds are affected by environmental factors such as growing condition of the food, climate, storage and cooking conditions (Caridi *et al.*, 2007).

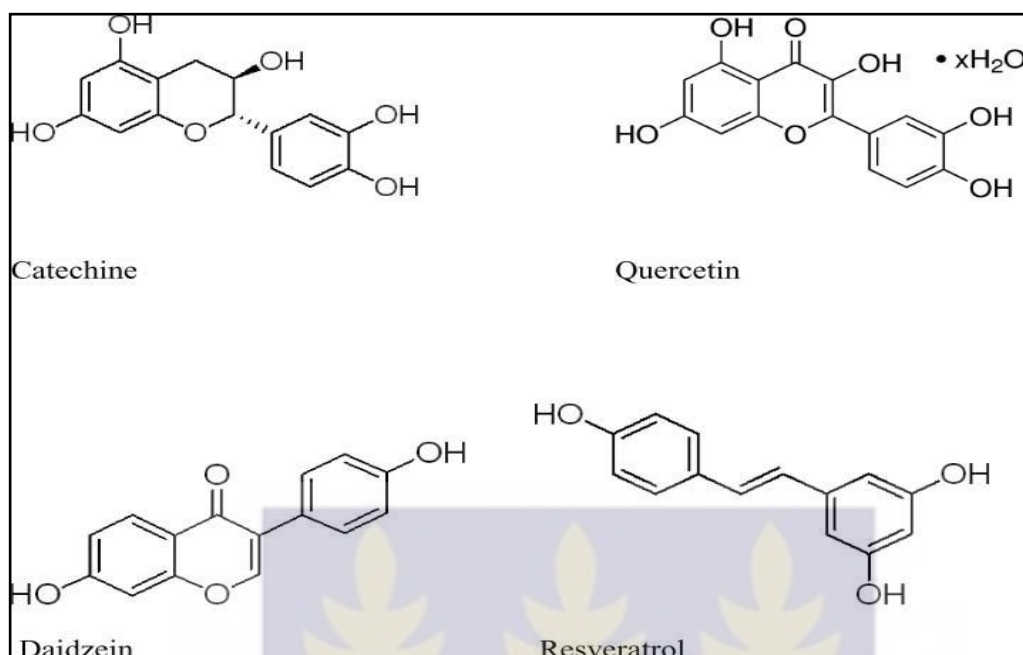


Figure 2. 2: Structure of some polyphenols: Source (Landete, 2013)

2.9.2.1.2 Tannins

Tannins are ranked the third most important polyphenolic compound that are found in many fruits, vegetable and feedstuffs (Biagi *et al.*, 2010) and can be extracted from the wood of several trees. Tannins are water-soluble polyphenols that are present in many plant foods and can be classified into two categories: hydrolyzable and non-hydrolyzable or condensed tannins. Tannins have been known for the detrimental effect that they exert on human and animal health thus have received a lot of attention due to its ability to reduce digestibility of dietary protein by forming insoluble complexes with dietary protein and digestive enzymes (Biagi *et al.*, 2010). Tannins, despite these anti-nutritional properties also play beneficial roles such as antibacterial and anti-diarrheic. They act as metal ion chelators and antioxidants making it beneficial to health as well. Tannins have been found in a variety of plants including food grains such as sorghum, millets, barley,

dry beans, faba beans, peas, carobs, pigeon peas, winged beans, and other legumes as well as in most fruits (Chung *et al.*, 1998).

2.9.2.1.3 Phenolic acids

Phenolic acids are simple molecules such as caffeic acid, vanillin and coumaric acid. Phenolic acids form diverse groups that are widely distributed in plant based foods. The two main forms include “hydroxybenzoic” such as gallic acid and “hydroxyl cinnamic acids” such as caffeic acid and ferulic acid. This results in differences in their susceptibility to degradation and even the extraction method (Dykes and Rooney 2007; Ignat *et al.*, 2011). The cinnamic acids are more common. Phenolic acid compounds are universally distributed in plants in both free and bound forms. Phenolic acids are easily absorbed and they are beneficial to health because they work as antioxidant; preventing cellular damage caused by free radical oxidation reactions. They may also promote anti-inflammatory conditions in the body when eaten regularly. Dietary sources of phenolic acids include mangos, berries, apples, citrus fruits, plums, cherries, kiwis, onions, tea, coffee, red wine, and flour made from whole wheat, rice, corn or oats among others (Landete, 2013).

2.9.2.1.4 Stilbenes and lignans

These are the least present polyphenol in foods and include resveratrol, which has been found to have a great potential for its anti-cancer and anti-aging benefits and constitute the main group (Francisco and Resurreccion, 2008). Resveratrol's estrogenic activity has led ongoing investigations of its potential use as a chemotherapeutic agent in breast cancers (Francisco and Resurreccion, 2008). Stilbenes inhibit cellular events associated with tumor initiation, promotion, and progression (Ignat *et al.*, 2011). Usually these polyphenol are produced in the plant mainly in response to infection and to stress conditions.

2.9.2.2 Ascorbic acid/ Vitamin C

Studies have established that consumption of functional foods especially of fruits and vegetable is known to protect against most aging-related and chronic diseases including cardiovascular disorders and cancer (Franke *et al.*, 2004). Vitamin C or L-ascorbic acid, a group of vitamins is an essential nutrient for humans and certain other animal species. It is required for a wide range of essential metabolic reactions specially its ionic form; ascorbate (Phillips *et al.*, 2010). Vitamin C is an essential water-soluble vitamin long known to be characterized by bleeding gums, impaired wound healing, anaemia, fatigue, and depression, and even fatal when deficient in human diet (Phillips *et al.*, 2010). According to Bernal *et al.*(2011), to ensure the adequate intake of vitamins, the human diet and food products can be enriched with vitamins or may be in the form of multivitamin; tablets usually administered as nutraceutical or functional ingredient. In biological systems and organisms, ascorbate acts as an antioxidant, since it protects the body against oxidative stress, and act as a cofactor in enzymatic reactions (Franke *et al.*, 2004). The recommended daily allowance of Vitamins C based on biochemical evidence; 75 mg/day for women and 90 mg/day for men in the US (Landete, 2013). It should be noted that, vitamin C is subject to oxidative and enzymatic degradation to dehydro ascorbic acid (DHAA) and also irreversible oxidation reducing its efficiency in providing the health benefits. These degradations may be initiated by light, pH, temperature (heat), oxygen exposure, the presence of oxidizing metals or enzymes and should be controlled even during its analysis on foods and during processing of vitamin C rich foods (Phillips *et al.*,2010).Vitamin C content in food can be analysed by both volumetric and HPLC methods.

Excellent food sources of vitamin C include broccoli, bell peppers, kale, cauliflower, strawberries, lemons, mustard and turnip greens, Brussels sprouts, papaya, chard, cabbage,

spinach, kiwifruit, snow peas, cantaloupe, oranges, grapefruit, limes, tomatoes, zucchini, raspberries, asparagus, celery, pineapples, lettuce, watermelon, fennel, peppermint, and parsley. Fortunately some of these foods are readily available among the Ghanaian food system making its health benefits realized by consumers.

2.9.3.3 Carotenoids in food

Carotenoids, like many other bioactive compounds provide antioxidant benefits to the body thus have received considerable interest by researchers, health professionals and regulatory agencies (Rao and Rao, 2007; Jomova and Valko, 2013). Carotenoids are hydrophobic molecules with very low solubility in water functioning in hydrophobic areas of the cell (Jomova and Valko, 2013). Carotenoids are a class of more than 600 naturally occurring pigments synthesized by plants, algae, yeast, fungi and photosynthetic bacteria (Rao and Rao, 2007). They are present as micro-components in fruits and vegetables and are responsible for their yellow, orange and red colours thus fruits and vegetables provide most of the carotenoids in the human diet. There are two main classes of carotenoids; carotenes (α -carotene, β -carotene or lycopene) and xanthophylls (β -cryptoxanthin, lutein or zeaxanthin) with each one having a variety of carotenoids. Carotenoids can be acyclic (example; lycopene), monocyclic (example; γ -carotene), or dicyclic (example; α - and β -carotene). Dietary carotenoids are absorbed, converted to vitamin A and may be slightly altered, deposited and utilized (Rodriguez-Amaya, 2001).). Lycopene, a member of the carotenoid family of phytochemicals is a lipid soluble antioxidant, highly unsaturated and has been studied to play the role in the prevention of prostate cancer (Rao and Rao, 2013). Carotenoids may also exist as provitamin A or other forms which can be converted to vitamins A in the body and examples include β -carotene, α -carotene, and β -cryptoxanthin (Rao and Rao, 2007). The most potent and widespread among the provitamin A

carotenoids is the β -carotene (Bernal *et al.*, 2011). These compounds show antioxidant and immune-modulation activities, and can prevent degenerative diseases, such as cardiovascular diseases, diabetes, and several types of cancer especially prostate and digestive-tract tumours (Bernal *et al.*, 2011). Although carotenoids are present in many common human foods, a review by Rao and Rao (2007) reveals that deeply pigmented fruits, juices and vegetables constitute the major dietary sources with yellow-orange vegetables and fruits providing most of the β -carotene and α -carotene, orange fruits providing α -cryptoxanthin, dark green vegetables providing lutein and tomatoes and tomato products; lycopene. Carotene and lycopene have been shown to be inversely related to the risk of cardiovascular diseases and certain cancers whereas lutein and zeaxanthin to the disorders related to the eye (Jomova and Valko 2013). The antioxidant properties of carotenoids have been suggested as being the main mechanism by which they afford their beneficial effects.

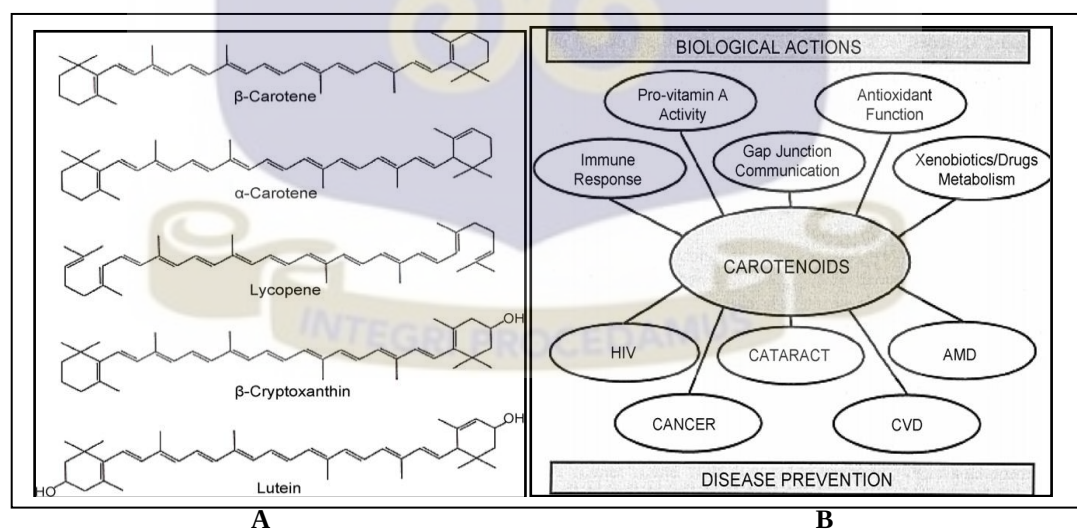


Figure 2. 3: **A**, Structure of some common dietary carotenoids; Source Jomova and Valko (2013), **B**: Role of carotenoids in the prevention of chronic diseases; Source Rao and Rao, (2007).

The carotenoid composition of foods are affected by factors such as cultivar or variety; part of the plant consumed; stage of maturity; climate or geographic site of production; harvesting and postharvest handling; processing and storage (Rodriguez-Amaya and Kimura 2004). Factors such as temperature, light and pH have also been found to produce alterations that can influence the colour of foods as well as their nutritional value (Jomova and Valko, 2013).

Carotenes are readily soluble in petroleum ether, hexane, and toluene; xanthophylls dissolve better in methanol and ethanol thus during its extraction carotenes are best extracted in organic solvents (Rodriguez-Amaya and Kimura, 2004). Carotenoids can be analysed by spectrophotometric method or by chromatographic methods.

2.9.2.4 Antioxidants in food

Antioxidants in food continue to be the main drive for the consumption of functional foods as most of the bioactive compounds plays their physiological role as antioxidants in the prevention of most diseases caused primarily by cell damage from oxidative stress (Molyneux, 2003). Antioxidants are chemical compounds that can bind to ‘free radicals’ resulting from oxidation; preventing them from damaging healthy cells and its activity in foods associated with the presence of polyphenols and vitamins (Azmir *et al.*, 2013). Free radical is any atom, molecule or compound that presents unpaired electrons and is able to receive or give them; acting as both oxidant and a reducer (Ferrari and Torre, 2003).

Oxidative stress to cells which is the consequence of an imbalance of pro-oxidants and antioxidants in the organism, is rapidly gaining recognition as a key phenomenon in the development of chronic diseases (Dhalla *et al.*, 2000; Moylan and Reid, 2007). Antioxidants defence available within the cell and extracellular should thus be adequate to

protect against oxidative damage (Landete, 2013). Vitaglione *et al.* (2005) reported that the amount and type of ingested fats, the intake of dietary fibre and the consumption of antioxidant compounds have been correlated to various chronic degenerative diseases including cardiovascular disease and some cancers. Oxidative stress occurs when the productions of oxidants is offset by the ability of the cell to readily detoxify these agents and are sometimes caused by inflammation, microbial infection and dietary habits (Câmara *et al.*, 2013).

According to Diplock *et al.* (1999) the development and existence of an organism in the presence of O₂ is associated with the generation of reactive oxygen species (ROS). ROS are responsible for the oxidative damage of biological macromolecules such as DNA, carbohydrates and proteins. ROS include hydroperoxyl radical (OH), the nitrogen oxide radical (NO), and alkyl peroxy free radicals, which are regularly produced in animals and humans under physiological and pathological conditions (Francisco and Resurreccion, 2008). ROS plays a crucial role in the various steps that initiate a lot of degenerative diseases and chronic conditions including CVD and atherosclerosis, hypertension, diabetes and Alzheimer's disease (Câmara *et al.*, 2013; Francisco and Resurreccion, 2008). Phenols thus protect against cellular oxidative stress by several possible mechanisms, such as scavenging free radicals, inhibiting or activating redox enzymes, or acting as metal chelators (Câmara *et al.*, 2013).

Naturally all forms of life maintain a reducing environment within their cells. This is made possible by enzymes that maintain the reduced state through a constant input of metabolic compounds (Landete, 2013). Endogenous antioxidant defences of the human body such as superoxide dismutase unlike the exogenous antioxidants obtained from the diet are capable of scavenging free radicals and repairing oxidative damages (Francisco and Resurreccion, 2008). Free radicals such as peroxy radicals, the superoxide anion, and the hydroxyl

radical are responsible for many of the damaging reactions (Pamplona, 2008). Low levels of antioxidants or inhibition of the antioxidant enzymes, cause oxidative stress and may damage or kill cells (Landete, 2013). It should however be noted that excessive accumulation of antioxidants in the body can result on liver damage and carcinogenesis (Molyneux, 2003).

The antioxidant activity in foods is associated with the presence of polyphenols and vitamins and may be determined quantitatively by the use of spectrophotometric methods such as the use of DPPH assay (1,1-Diphenyl-2-picrylhydrazyl or 2,2-Diphenyl-2-picrylhydrazyl), ABTS assay (2,2'-azino-bis-(3-ethylbenzothiazoline- 6-sulfonic acid) among others several methods including, TEAC (Trolox Equivalent Antioxidant Capacity), FRAP (Ferric Reducing Ability of Plasma), TRAP (total radical trapping antioxidant parameter), and ORAC (Oxygen Radical Absorbance Capacity), with the ORAC method being the most common (Landete, 2013).

It could be concluded that antioxidants in food and their analysis is very essential for the information of consumers in their choices of foods. There exists different methods for analyzing antioxidants in foods, however the feasibility, sensitivity and accuracy should be considered. Antioxidants in food are present in different levels and thus dietary intake should be diversified so as to meet the dietary requirements of these antioxidants in our daily quest to prevent and manage degenerative.

Other bioactive compounds in food include sulphur rich compounds found in some foods including broccoli, cabbage, brussel sprouts among others which have all been shown to reduce significantly the risk of cancer development (Bernal *et al.*, 2011). Generally, bioactive compounds in foods play significant roles in our health, thus must be researched into to bring out the scientific proof to buttress their frequent usage among consumers. This would ensure ultimate health attainment and general wellbeing.

CHAPTER 3

3:0 MATERIALS AND METHODS

3.1. Study design

The study was conducted in two parts. The first part was a qualitative consumer survey about the knowledge, usage, perception and determinants of the use of functional foods within the Greater Accra region. The second part of the study was a chemical analysis on selected foods perceived to have nutraceutical properties by consumers for the identification and quantification of some bioactive compounds.

3.2. Consumer survey

3.2.1. Study area and justification

The consumer survey was cross sectional, conducted at two different settings; urban and peri- urban settings in the Greater Accra region of Ghana. The urban setting was selected from the Greater Accra metropolis while the non-urban setting was selected within the peri-urban centre in the region. The Greater Accra metropolis is the capital city of Ghana and with a population of 4,010,054 million people (National Population and Housing Census 2010). The city of Accra continues to be one of the fastest growing metropolises in Africa. The metropolis consist of mixed population from the various parts of the country with differences in ethnicity, level of education, income, economic status, beliefs among other key socio-demographic characteristics.

The urban setting was purposively sampled to include various diversified consumers at strategic communities/ areas in the city of Accra. At these areas, various consumer groups were identified and conveniently sampled based on the ease of having them in groups to

facilitate the data collection process. Thus the GREDSA estate Methodist church (**Church**) at Teshie, the Pentecost University College (PUC) (**Institution**) at Sowutuom, and the 37 Military Hospital (**Hospital**) at the 37 area; were chosen. The peri-urban setting consisted of “**Danfa**”, “**Adoteiman**”, “**Otinibi**” and “**Kweiman**” communities all within the Greater Accra Region.

3.2.1.1. Why the selection of a Church, Institution and Hospital

The church was chosen specifically based on the diversity it presents in the population. Religion and spirituality are all found to affect people’s beliefs and perceptions and the willingness to use functional foods. The church now also serves as avenue for various knowledge and information delivery aside spiritual activities thus people are given educational talks on healthy foods. An institution (PUC) was chosen as participants are believed to have higher educational level, easy access to information and also the ease (convenience) of having the staff as a group to facilitate the data collection process.

The hospital setting was chosen to help have consumers (patients) as a group and may be battling with certain ailments thus may access dietary information from health workers which would possibly influence their usage of some of these functional foods.

3.2.1.2 Why the peri-urban setting

The peri-urban setting was chosen to help compare consumers’ knowledge, perception and usage of functional foods based on the different background and socio demographic characteristics.

3.2.2. Sample Size, Procedure and Inclusion Criteria

The sample size consisted of approximately 360 consumers; 180 each of urban and peri-urban dwellers. This was obtained after the adoption of the formula by Moore and

McCabe, (1993) at a confidence level of 95% and a 0.05% margin of error ($n = 384.16$) and approximated to 360 consumers.

$N = (z^*/2m)^2$; Where n is the sample size, Z^* = confidence level at a critical value of 95% (1.96) and M = margin of error at 0.05 (5%)

The specific consumer groups were conveniently selected within the urban setting and respondents were randomly chosen from the group to be part of the study. This procedure was adopted since the survey was a general consumer survey with the main variable being one's location. The criteria included; consumers' willingness to partake in the study and individuals older than 18 years.

Table 3.1: Sample size distribution of participants across the two study locations.

Urban	Non urban
Church= 48	Members of households at Damfa,
Institution= 47	Adoteiman , Kweiman & Otinibi = 180
Hospital (OPD) = 85	

3.2.3. Data Collection and Quality Assurance

3.2.3.1. Interviews

Consumers were made to fully understand the reasons for the study after their consent were sought and their willingness to partake in the study declared. Consumers were interviewed face to face and taken through all the questions which lasted for an average of about 15 minutes. In order to ease the understanding of what a functional food is, subjects were first given a brief introduction of what constitute a functional food. There was an introductory conversation to investigate whether subjects encountered at the hospital per

chance has been interviewed before in any of the other areas selected within the various study locations to prevent possible duplication of subjects especially those in the urban setting. This is because the 37 Hospital is a specialized health institution open to all people in and within the region. Thus subjects could be encountered twice in the study.

A semi-structured questionnaire (**Appendix 2**) was administered face to face to consumers after it has been pretested. Field assistants were also recruited and trained to assist in the data collection; informed consent acquisition and questionnaire administration. It was also ensured that the field assistants could speak the Ga language which is the dominant traditional language within the region. In all, 360 questionnaires were administered at the end of the data collection period (November 2013- January 2014). There were 360 completed questionnaires for both urban and non-urban settings; 180 questionnaires for each setting respectively. The questionnaire included questions which sought to find information under following sub headings, *demographic data, knowledge and perception on functional foods, usage of functional foods and their benefits, adoption and willingness to use functional foods as well as the use of nutraceutical supplements and drugs.*

3.2.3.2. Ethical consideration

Ethical clearances were obtained from the Ethical committee for the Humanities (ECH), University of Ghana and the Internal Ethical Review Board at the 37 Military Hospitals (**Appendix 1**). Verbal consent was sought from all subjects before been interviewed during the survey.

3.3. Chemical analysis

The second part of the study involved laboratory determination of the bioactive components of some of the common foods perceived by consumers to have nutraceutical properties.

3.3.1 Sample Selection

Samples were selected after food commodities perceived by consumers to have nutraceutical properties were analyzed for their frequency of usage/ known. A total of eighty-two (82) different food commodities and systems were perceived to have nutraceutical properties. The commodities ranged from fruits, vegetables, cereals, legumes, nut and seeds, drinks, fish, dairy, sea foods, herbs, natural spice among other foods. The frequency of usage of FFDs from the consumer survey revealed, leafy vegetables (lettuce, spinach, waterleaf, “shurey”, “kontomire”, “gboma”, “adeime”, “alefu”), dandelion, orange, moringa, watermelon, banana, pawpaw, carrot, cabbage and garlic are among the top ten foods perceived to have nutraceutical properties. Cocoyam leaves “kontomire” (*xanthosoma plant*), watermelon (*Citrullus lanatus* var. *Lanatus*), prekese (*Tetrapleura tetraptera*), sweet basil (*Ocimum basilicum*) and black velvet tamarind (*Dialium guineense* Wild) were selected to determine of their specific nutraceutical properties.

3.3.1.1 Cocoyam leaves (*Xanthosoma plant*)

Cocoyam leaves are among the most commonly used dark green leafy vegetable (DGLV) in Ghana. It is known in the local dialect as “kontomire” and used in the preparation of stews and soups. Cocoyam leaves are perceived to aid in the prevention of anemia by helping in blood formation, provision of vitamins, immune booster and for general wellbeing.



Plate 3. 1 Cocoyam plant and Leaf (*Xanthosoma* plant)

3.3.1.2 Watermelon (*Citrullus lanatus* var. *Lanatus*)

Watermelon (*Citrullus lanatus* var. *lanatus*) is a cucurbit that produces large fruit, usually with red-colored flesh. The fruit is sweet and has high moisture content, providing a delicious source of carbohydrates and water. Watermelon also contains large amounts of lycopene and citrulline in addition to ascorbic acid, potassium, flavonoids, and beta carotene (Perkins-Veazie *et al.*, 2012). The seeds are also perceived to reducing high blood pressure and inflammation of the GIT and de-wormer.



Plate 3. 2 Watermelon (*Citrullus lanatus* var. *lanatus*)

3.3.1.3 Prekese (*Tetrapleura tetraptera*)

Tetrapleura tetraptera commonly known as “prekese” in Ghana is one of the indigenous tree plants. It is known to be native to Asia and Ghana. It is mostly used among the Akans as a spice in soups. It is also boiled and taken as tea. Prekese is perceived to reduce high blood pressure, provide good eyesight, helps in blood circulation and cleaning the blood system.



Plate 3. 3: Prekese (*Tetrapleura tetraptera*)

3.3.1.4 Sweet basil (*Ocimum basilicum*)

Sweet basil is a shrub native to Asia and Africa and used mainly in Italian and Thai dishes and teas. It is used as an aromatic spice in meal preparation especially in soups in Ghana. It has a unique sweet smell and flavour and is referred to locally as “Akokommessa”. Sweet basil from the survey is perceived to be anti-diabetic and also for general wellbeing however its usage is limited to a few households in Ghana.



Plate 3. 4: Sweet basil (*Ocimum basilicum*)

3.3.1.5 Black (African) velvet tamarind (*Dialium guineense* Wild)

Black (African) velvet tamarind, also referred to as “lukyee” in Thai is a wild plant and occurs mostly in Thailand and in some part of Africa

. It is known locally as “yereyi” and is eaten as snack. It is perceived to boost the body immune and improve general wellbeing.



Plate 3. 5 Black (African) velvet tamarind (*Dialium guineense* Wild)

3.3.2 Sample Collection, Preparation and Extraction

3.3.2.1 Sample collection

Cocoyam leaves and sweet basil leaves were obtained from a garden on the university of Ghana campus while the Black (African) velvet tamarind, *Tetrapleura tetraptera* “Prekese” and water melon were obtained from the Madina market in Accra. All samples were identified at the Plant Biology Department of the University of Ghana.

3.3.2.2 Sample preparation and extraction

3.3.2.2.1 Petroleum ether extraction of samples

A representative amount of sample within the range of (0.1000g -1.000g) was taken, ground with pyrogallol using a mortar and pistil in 25ml cold acetone. Pyrogallol was added to prevent the oxidation of active compounds. The mixture was filtered (Whatman N^o 4) and the residue was re-extracted under the same conditions until the extraction solvent became colourless. The filtrates were pulled together and partitioned on 20ml petroleum ether in a 500ml separating funnel. The acetone was washed away with about 1000ml distilled water by draining away the aqueous layer. The petroleum ether layer was

dried by passing it through anhydrous sodium sulphate sited on a cotton wool at the base funnel. The extract was collected into a storage tube and stored at 4°C (Rodriguez-Amaya, and Kimura, 2004).

3.3.2.2.2 *Methanol extraction*

For the determination of the total polyphenols and tannins, a representative amount of the test sample (0.500-1.000)g was ground in a mortar with 25ml of methanol and pyrogallol. The mixture was filtered and the residue re-extracted under the same conditions until the extraction solvent became colourless. The extract obtained was filtered through Whatman no 4 filter paper and the filtrate was collected into a falcon tube and stored at 4°C. Extraction for antioxidant analysis was performed using methanol/ water solvent in a ratio of (70:30) % respectively (Rodriguez-Amaya, 2001).

3.3.3 Total Phenolic Content Determination

Total phenolic content was determined by the Folin-Ciocalteu method as described by Lamien -Meda *et al.* (2008) using Gallic acid as a standard for the calibration curve. Results were expressed as milligrams of Gallic acid equivalent (GAE) per gram of samples. 1 ml of standard solution (0, 0.2, 0.4, and 0.6, mMol/L of GA) were added to 2ml Folin-Ciocalteu reagent 0.2N (diluted 1:10). The mixture was allowed to stand at room temperature in subdued light for five minutes before adding 2ml of sodium carbonate solution (75g /L; 700 ml Mol) and incubated. Results were read at 760 nm after 10 minutes of colour development using the UV- visible spectrophotometer (CECIL; CE3041 3000 series). A standard curve was plotted ($Y = 2.916X + 0.308$; $R^2 = 0.936$). This procedure was repeated for the methanolic extract of test samples.

Total polyphenol content;

$$\frac{\text{concentration}(\text{mlMol} / \text{L}) * \text{DF} * \text{volume of extract}(\text{L}) * \text{Amount of test sample}(\text{L})}{\text{weight of sample}(\text{g})}$$

DF= Dilution factor.

3.3.4 Ascorbic Acid Determination (AOAC Method 1990)

3.3.5.1 Sample Preparation

A representative amount of the test samples was weighed and homogenized using mortar and pestle with approximately 25 ml distilled water. The sample was filtered through a No. 4 Whatman filter paper.

3.3.5.2 Standard Preparation

Approximately 2g of potassium iodide was weighed in 5ml water in a 50 ml Erlenmeyer flask in triplicate. To this was added 15ml of indophenols dye followed by 10ml of 1N HCl. The mixture was allowed to stand for 2 minutes. This was titrated with freshly prepared 0.01N sodium thiosulphate using 2 ml starch until there was no change in colour. If 15ml dye required (6.3) ml of sodium thiosulphate;

$$\begin{aligned} 1\text{ml dye} &= \frac{1}{1000} * \frac{\text{Na}_2\text{S}_2\text{O}_3(\text{ml}) \text{ used} * \text{normality of Na}_2\text{S}_2\text{O}_3 * 88 * 1000}{\text{ml of dye}} \\ &= \frac{1}{1000} * \frac{6.3 * 0.01 * 88 * 1000}{15} \\ &= 0.3696 \text{ (dye equivalent)} \end{aligned}$$

3.3.5. 3 Titration

20 ml of the extract was pipette in a 100ml volumetric flask and was made up to the volume using 0.4 % oxalic acid. 10 ml aliquot was pipetted for titration and 15ml of 0.4%

oxalic acid was added. This was then titrated immediately with a 0.04% indophenols dye to a faint pink end point which last for 5 to 10 seconds. This was repeated in triplicate for all samples and the end point recorded.

*Mg ascorbic acid per 100ml extract = dye equivalent (0.3696) * titre * dilution (200).*

- Where dye equivalent is obtained from the titration of the standard dye prepared and titre is obtained from the titration of the test samples.

3.3.5 Total Tannins Determination

The total tannin content was evaluated by using the reference method of European Community (2000) with a slight modification. Briefly, 1 ml of the extract (1: 100 fold dilutions) was mixed with 5 ml of distilled water, 1ml of ferric ammonium citrate (3.5 g/L) which is a day old and 1ml ammonia solution (8ml/L). The mixture was then vortex to ensure thoroughly and the absorption is measured at 525 nm after 10 min of incubation against a blank consisting of 1ml of the extract, 6ml of distilled water and 1 ml of ammonia solution. The blank was obtained per each test sample. Tannic acid (0, 0.2, 0.4, 0.6mMol/L) was used as reference compound to produce the standard curve, ($y = 2.309 \times + 0.142$, $R^2 = 0.999$) and the results were expressed as mg of tannic acid equivalent (TAE)/g of extract.

Tannins content =

$$\frac{\text{concentration (mlMol / L)} * \text{DF} * \text{volume of extract (L)} * \text{Amount of test sample (L)}}{\text{weight of sample (g)}}$$

3.3.6 Antioxidant Activity Determination

Antioxidant assays were determined using the DPPH[•] radical scavenging ability method (Goupy *et al.*, 1999). Briefly, a working DPPH[•] solution (0.048 mg/mL) was prepared. Prior to analysis, serial dilutions of the test samples) were prepared at concentrations of (20, 15, 10 and 5) mg/ml respectively. In all experiments butylated hydroxyl toluene (BHT) was used as the standard. The standard/diluted sample (500 µL) and DPPH[•] working solution (500 µL) were added to a micro-centrifuge tube. After vortexing, the tubes were left in the dark for 30 minutes at room temperature. The absorbance was then measured against methanol (blank solution) at 515 nm. The decrease in absorbance of the sample extract was calculated by comparison to a control (500 µL sample extraction solvent and 500 µL DPPH).

Lower absorbance of the reaction mixture indicates higher free radical scavenging activity.

$$Q (\% \text{ Reduction of DPPH}) = \left(1 - \frac{A_0}{A_c} \right) * 100; \text{ where } A_0 \text{ is the absorbance of the control and } A_c \text{ is the absorbance of the test samples.}$$

3.3.7 Total Carotenoids Determination

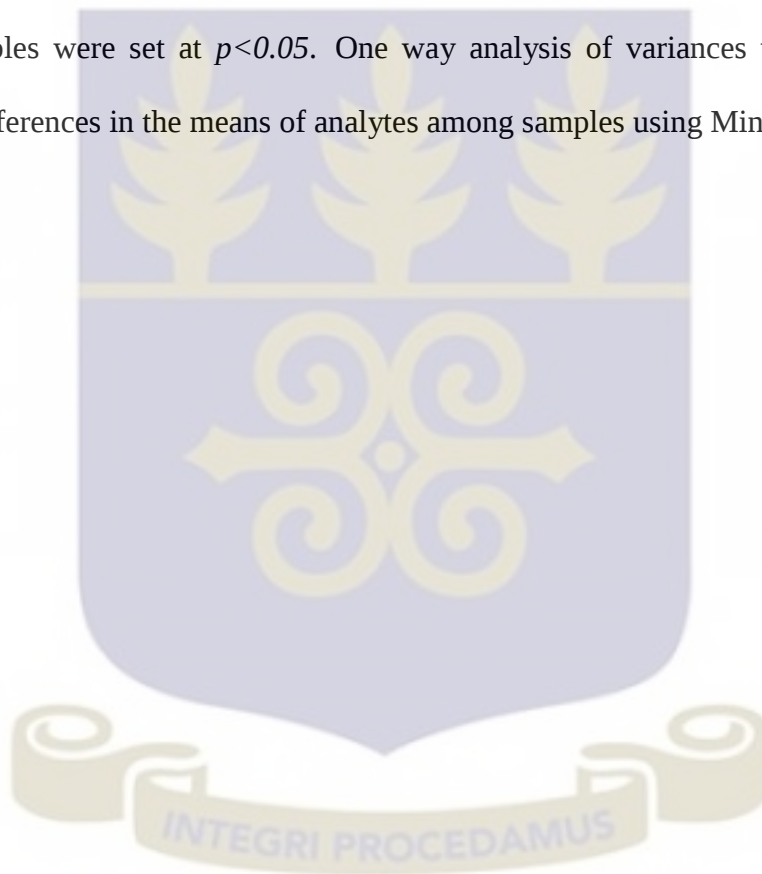
Total carotenoid content was determined by the method described by Rodrigues-Amaya, (2001). Total carotenoid content of test samples were determined using 3ml of the petroleum ether extract of each test sample. The absorbance were measured at 450nm using the spectrophotometer. The concentrated extract was diluted so that the absorbance was between 0.2 and 0.8.

Total carotenoid content (µg/g) =

$$\frac{\text{Absorbance} * \text{total volume of extract (ml)} * 10^4}{\text{Sample weight (g)} * \text{absorption coefficient of B-carotene (2592)}}$$

3.3.8 Statistical Analysis

Completed questionnaires were coded and entered into the Statistical Package for Social Sciences (SPSS Version 16). Frequencies and proportions were used to summarize categorical data such as sex, occupation, level of education, knowledge on functional food, usage and perception information source and disease conditions. Crosstab was used to compare categorical variables among the two locations and also to determine the association between variables using the Pearson chi square values. Significance levels among variables were set at $p < 0.05$. One way analysis of variances was employed to determine differences in the means of analytes among samples using Minitab version 14.



CHAPTER 4

4:0 RESULTS AND DISCUSSION

4.1 Introduction

This section presents the results of both the consumer survey and the chemical analysis. The first part is on the consumer survey and the second part is on the laboratory chemical analysis on selected FFDs.

4.2 Consumer Survey on Functional Foods among Urban and Peri- Urban Communities in the Greater Accra Region.

4.2.1 Consumer background characteristics

Overall female respondents outnumbered the males in both locations of study. The total males in the study constituted 38.3% while females were 61.7%. (Table 4.1). The age of respondents ranged from 18 to above 65 years and most of them (40.8%) were within the age range of 18-29 years for both the urban and peri-urban locations. Respondents above 65 years were 11.1%. The Akans were the highest ethnic group (36.4%) among the total number of respondents. In the peri-urban population however, most respondents belonged to the Ga/Adangbe ethnic group. About fifty-four percent (53.9%) of total number of respondents were married or co-habiting. A total of 115 (31.9%) respondents had JHS/ Middle or Form four educations. The urban-respondents had majority of consumers having tertiary level of education; a total of 68 out of the 72 respondents. Majority of the respondents were Christians (91.4%). Most respondents (28.6%) were salaried workers. The average monthly income of most respondents was within the range of 100-<300 (22.5%). A total of 6 respondents earn > 1500 and were within the urban population. With the exception of gender and religion there were significant differences among all other

socio-demographic variables (age, ethnicity, marital status, level of education, occupation and income) with respect to the urban and peri-urban consumers (p-value <0.05).

Table 4.1 Socio-demographic characteristics of consumers by location (N=360)

Variables	Location of consumer (n (%))			P-value
	Total	Urban n=180	Non - Urban n=180	
Gender				
Male	138(38.3)	78(43.3)	60(33.3)	0.051
Female	222(61.7)	102(56.7)	120(66.7)	
Age				
18-29	147(40.8)	68(37.8)	79(43.9)	0.035*
30-39	80(22.2)	32(17.8)	48(26.7)	
40-49	42(11.7)	25(13.9)	17(9.4)	
50-59	51(14.2)	33(18.3)	18(10.0)	
>60	40(11.1)	22(12.2)	18(10.0)	
Ethnicity				
Ewe	71(19.7)	41(22.8)	30(16.7)	<0.001*
Ga/ Adangbe	122(33.9)	25(13.9)	97(53.9)	
Northern ethnicity	32(8.9)	17(9.4)	15(8.3)	
Akan	131(36.4)	96(53.3)	35(19.4)	
Foreigner	4(1.1)	1(0.6)	3(1.7)	
Marital Status				
Single	129(35.8)	76(42.2)	53(29.4)	0.026*
Married	194(53.9)	92(51.1)	102(56.6)	
Widow(er)	20(5.6)	7(3.8)	13(7.2)	
Divorce	17(4.7)	5(2.7)	12(6.6)	

P-values with * means statistically significant

Table 4.1 Cont'd: Socio-demographic characteristics of consumers by location

Variables	Total	Location of consumer (n(%))		P-value
		Urban n=180	Non - Urban n=180	
Education				
No formal education	23(6.4)	3(1.6)	20(11.1)	<0.001*
Primary	37(10.3)	9(5.0)	28(15.5)	
JHS/ Middle school/ Form 4	115(31.9)	29(16.1)	86(47.7)	
Vocational / Technical/ commercial	27(7.5)	16(8.8)	11(6.1)	
Secondary/A&O Level, six form	54(15.0)	23(12.7)	31(8.6)	
Tertiary	74(20.6)	70(38.8)	4(2.2)	
Post graduate	30(8.3)	30(16.6)	0(0)	
Religion				
Christianity	329(91.4)	168(93.3)	161(89.4)	0.23
Moslem	24(6.7)	11(6.1)	13(7.2)	
Traditionalist	4(1.1)	1(0.5)	3(1.6)	
Atheist	3(0.8)	0(0)	3(1.6)	
Occupation/Profession				
Not Working	71(19.7)	29(16.1)	42(11.7)	<0.001*
Salary worker	103(28.6)	79(43.9)	24(13.3)	
Vocational/ Technical worker	50(13.9)	17(9.4)	33(18.3)	
Trader	72(20.0)	18(5.0)	54(15.0)	
Business owner/self employed	39(10.8)	21(11.7)	18(10..0)	
Students	15(4.2)	12(6.7)	3(1.7)	
Pastor	3(0.8)	1(0.6)	2(1.1)	
Others	7(1.9)	3(1.7)	4(2.2)	
Income				
None	72(20.0)	28(15.5)	44(24.4)	<0.001*
<50	25(6.9)	4(2.2)	21(11.6)	
50-< 100	54(15.0)	12(6.6)	42(23.3)	
100- < 300	81(22.5)	30(16.6)	51(28.3)	
300-< 500	42(11.7)	27(15.0)	15(8.3)	
500-<1000	46(12.8)	40(22.2)	6(3.3)	
1000-< 1500	34(9.4)	33(18.3)	1(0.5)	
>1500	6(1.7)	6(3.3)	0(0)	

P-value (Pearson's Chi-square for categorical variables) .Statistical significance at $p < 0.05$

Marital status: Married include married and cohabiting

Others include; NGO staff, artist, farmer and chemist

P-values with * means statistically significant

The larger proportion of females than males in the study is consistent with the findings of the 2010 National Population and Housing Census (NPHC) of Ghana which reported a larger female population than males exist generally in Ghana and also for the Greater Accra region. There were (47.7%) and (52.3%) males and females respectively for the Greater Accra region (NPHC, 2010).

Most respondents were within the age range of 18-29 years. The United Nations Human Settlements Programme (UN-HABITAT), 2009 also reported similar findings that Accra's population consist mostly of the youth with 56% of the population under the age of 24 years; also typical of most urban centres. The Akan group was the largest ethnic group and this is because the group consisted of the Ashantis, Fantes , Brong Ahafo's, the Eastern and Western populace; a combination of about five regions in Ghana belonging to the Akan ethnicity. Higher proportion of the Ga/Adangbe ethnicity recorded for the peri-urban respondents was expected as this location is predominantly occupied by natives of the Ga/Adangbe ethnic group. This is the predominant ethnic group of the Greater Accra region.

About fifty four percent of the respondents were married. The mean marriage age in Ghana according to 2000 NPHC is 21 years thus fall within the age range that constituted most of the respondents interviewed for both urban and peri- urban respondents. According to the 2000 NPHC, about 48% of the population in Ghana both men and women were married or in some form of co- habiting.

Most of the respondents had at least JHS/ Middle/Form 4 educational level; the average educational level by most Ghanaians (NPHC, 2000). Tertiary educational level was high among the urban respondents. This could be attributed to the dynamics of the urban populace by the inclusion of staff from a higher institution of learning, a university; most of which were in administrative and teaching positions. Majority of the respondents were

Christians and this finding was consistent with the 2000 NPHC which reported 71.2% Ghanaians as being Christians. The presence of most salaried workers especially by the urban dwellers could also be attributed to Accra being the second most industrialized city in Ghana and having persons working in various industries; 22.34% of employment of the labour force is found in Accra city alone (United Nations Human Settlements Programme (UN-HABITAT), 2009). The average income of respondents was between (100-300) GhanaCedis as most people within the region belong to the informal service (manufacturing, marketing, finance, insurance, transportation and tourism) (UN-HABITAT), 2009).

4.2.2 Knowledge of FFDs

4.2.2.1 Awareness of FFDs

Majority of respondents were aware that some foods play medicinal role in the body (awareness of FFDs). There were 95% and 96% awareness of FFDs among urban and peri-urban respondent respectively (Figure 4.1) Awareness of FFDs was not significantly different with respect to location of the respondents ($p= 0.429$).

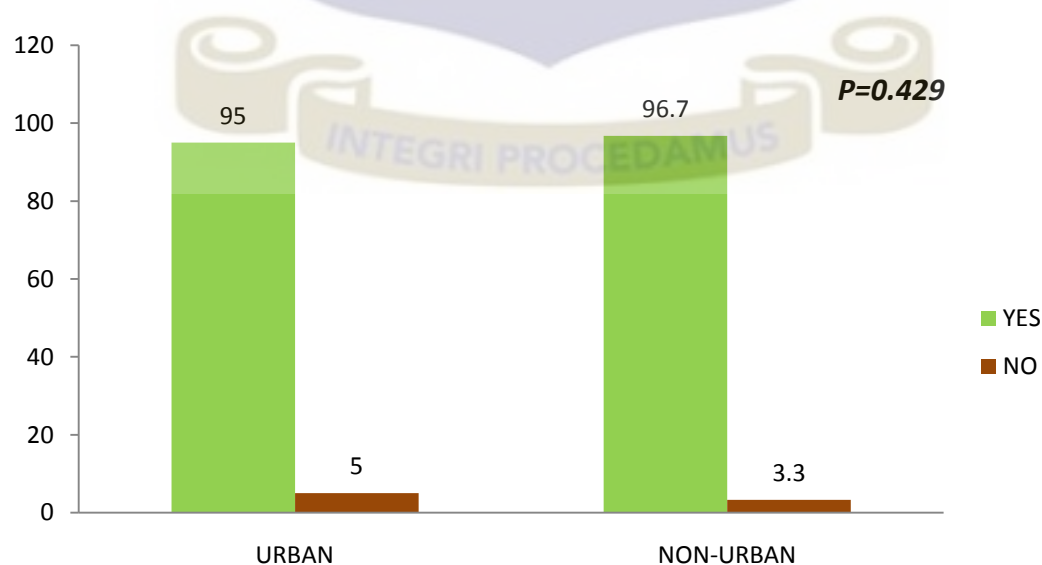


Figure 4. 1: Awareness of FFDs

Awareness of FFDS was found to be high among respondents in the study (> 90%). This finding contradicts that of ACNielsen (2005) in a global survey polling where awareness of healthy foods including FFDs was generally low. Increased awareness of FFDs by the consumers in this study could be attributed to the use of the term “foods with medicinal or health benefits instead of “functional foods” during the survey. Similarly, a study in the US reported that even consumers who admitted not being familiar with the term “functional foods” (79% North Americans), were aware that whole wheat cereals, vegetable juice, carrots, toast with high fiber and green tea had special health benefits and thus were frequently used (Urala *et al.*, 2011). Again high level of awareness could be identified with similar findings by Teck-Chai *et al.* (2013) where most Malaysians’ had some knowledge and awareness of traditional wellness, herbal medicines and the health benefits of foods, usually passed down through generations which is similar to the Ghana situation.

4.2.2.2 Knowledge on FFDs categories

Fruits and vegetable constituted the larger proportion of functional food categories known by respondents (39.2%) for both urban and peri-urban respondents. Other FFD categories known by respondents included herbs, spices, cereal and legumes. Types of FFDs known by consumers were significantly different ($p < 0.001$) among the urban and peri-urban respondents (Table 4.2).

Table 4.2: Knowledge of FFDS categories by consumers (N=360)

Category of FFDS Known	Total	Location of consumer		P-Value
		Urban (n=180)	Non – Urban(n=180)	
Don't know	15(4.2)	12(6.6)	3(1.6)	< 0.001*
Fruits and Vegetable only	141(39.2)	60(33.3)	81(45)	
Cereal only	2(0.6)	1(0.5)	1(0.5)	
Legumes and nut only	5(1.4)	4(2.2)	1(0.6)	
Natural spice only	3(0.8)	2(1.1)	1(0.5)	
Herbs only	11(3.1)	6(3.3)	5(2.8)	
Fruits ,vegetable , cereals and herbs only	18(5.0)	10(5.6)	8(4.4)	
Cereal, legumes and nut, natural spice, herbs	3(0.8)	0(0)	3(0.8)	
Fruits, vegetables, legumes and nut, natural spice, herbs, cereal, drinks, spread and sea foods	26(7.2)	7(3.8)	19(10.6)	
Herbs and cereals only	1(0.3)	1(0.6)	0(0)	
Fruits and herbs alone	6(1.7)	4(2.2)	2(1.1)	
Fruits, vegetables and natural spice	52(14.4)	26 (14.4)	26(14.4)	
Fruits , vegetables and natural spice	28(7.8)	21(11.7)	7(3.9)	
Vegetables only	26(7.2)	7(3.9)	19(10.6)	
Herbs and spice	9(2.5)	8(4.4)	1(0.6)	
Fruits , vegetables and sea foods	4(1.1)	3(1.7)	1(0.6)	
Others	10(2.8)	8(4.4)	2(1.1)	

Others include combination of the various food groups not categorized in the table.

Statistical significance at $P < 0.05$

P-values with * means statistically significant

Knowledge on the type of FFDS revealed that fruits and vegetables constitute the larger FFD group than all other food groups. IFIC (2007) found a similar trend where fruits and vegetables were the top functional foods identified by consumers during a survey on

‘Consumer Attitudes Toward Functional Foods and Foods for Health’, confirming that, the first thought that comes in mind when functional food is mentioned is basically fruits and vegetables. Quite a number of respondents did not know about any category of FFDs though awareness was high among the two locations, thus awareness could not be directly related to exactly what constitute a FFD by consumers. A study by Annunziata and Vecchio (2011a) found out that about 24% of respondents were unable to provide a definition of FFDs and therefore could not specifically provide what constitute a FFD. There were a combination of other food groups by consumers ranging from fruits, vegetables, natural spice, herbs, drinks, spreads, legumes and nuts among others. This is in agreement with the report of Dhanvijay (2013).which stated that, there exists no single straight forward categorization of FFDs generally.

4.2.2.3 Knowledge on medicinal components of FFDs

About seventy- seven percent (76.7%) of respondents had no knowledge on the medicinal or bioactive components of the FFDs known. Vitamin was the most known bioactive component of FFDs (10.6%). Antioxidant was only known by a total of 6 respondents and all within the urban location. Majority of respondents admitted that FFDs should not be used by unhealthy or ill persons only (96.1%). There were significant differences in consumers’ knowledge on the medicinal or bioactive components of FFDs as well as the reason why FFDs should not be used by only the ill/ unhealthy individuals (Table 4.3) between the urban and peri-urban respondents.

Table 4.3 Knowledge of FFDs components and who should use FFDs (N=360)

Knowledge on FFDS	Total	Location of consumer		P-value
		Urban N=180	Non - Urban N= 180	
Knowledge about medicinal/ bioactive components				
Don't know	276(76.7)	122(33.9)	154(85.6)	<0.001*
Vitamins only	38(10.6)	18(10.0)	22(12.3)	
Minerals only	6(1.7)	6(3.3)	0(0)	
Vitamins and minerals only	17(4.7)	14(7.7)	3(1.7)	
Proteins	3(0.8)	3(1.6)	0(0)	
Antioxidants only	6(1.7)	6(3.3)	0(0)	
Vitamins, minerals and fiber	2(0.6)	2(1.1)	0(0)	
Fiber only	4(1.1)	3(1.6)	1(0.6)	
Vitamin, minerals and protein	8(2.3)	6(3.3)	0(0)	
Should FFDS be used only by the unhealthy / ill persons				
Yes	14(3.9)	8(4.4)	6(3.3)	0.500
No	346 (96.2)	172(95.6)	174(96.7)	
Reason				
None	10 (3.9)	7(3.8)	3(1.7)	<0.001*
We need it to be healthy and live longer	185 (51.4)	75(41.7)	110(61.1)	
They help prevent diseases we all need them	137 (38.1)	90(50)	47(26.1)	
To help facilitate natural healing	8(2.2)	6(3.3)	2(2.2)	
All the above	20(5.6)	2(1.2)	18(10)	

Others include various combination of the various food groups not categorized in the table

Statistical significance at $P < 0.05$

P-values with * means statistically significant

With regards to the knowledge on medicinal or bioactive/ medicinal components of FFDs, a greater number of respondents were not knowledgeable in what impart the functionality of these foods (76.7%). Bornkessel *et al.* (2014) reported that ingredient awareness including bioactive constituents has been found to influence consumers' perception and

acceptance of functional foods. Other studies suggested that foods or products containing certain ingredients will be more successful on the market if the consumer is aware of the inherent ingredients (Del-Giudice and Pascucci, 2010; Chen, 2011)). Ingredient awareness has also been found to be directly related to health status, health motivation and information strategies and indirectly by educational level and age of the consumer in question (Verberke, 2005; Bornkessel *et al.*, 2014). Low level of knowledge on the medicinal components of FFDs may thus negatively affect FFD choice by consumers in the study. The most known bioactive ingredient by respondent was vitamins. This could be associated with increase nutritional knowledge on fruits and vegetables worldwide and their health benefits (Patterson *et al.*, 1995). Antioxidants and fiber was only known by a few respondents who belonged to the urban location. This is consistent with the earlier findings of Bornkessel *et al.*, (2014) where nutrients awareness has been found to be associated with high level of education; which was the case of the urban respondents. Most urban respondents had high educational levels and could access, read, and analyse information on foods and food labels including FFDs and products.

Majority of respondents conclusively admitted that FFDs should not be used by ill or sick persons only (96.1%); with reasons ranging from wanting to be healthy and live longer, prevent diseases and facilitate natural healing should the disease even arise. This is consistent with several studies which reported that today, foods are not intended to only satisfy hunger and to provide necessary nutrients for humans but also to prevent nutrition-related diseases and improve physical and mental well-being of the consumer (Young, 2000, Mollet and Rowland, 2002). The health effects of a functional food can either be maintenance of a state of well-being and health or reduction of the risk of pathologic consequences (Roberfroid, 2000a, Roberfroid, 2000b; Menrad, 2003). Arvanitoyannis and Houwelingen-Koukaliaroglou, (2005) also added that the increasing demand on functional

foods can be explained by the increasing cost of healthcare, the steady increase in life expectancy, and the desire of older people for improved quality of their later years. The role of diet and nutrition as determinants of chronic diseases has been well recognized, in that CDCP (2004) explained a WHO report released in 2003 which summarized the links between diet and obesity, diabetes, CVD, cancer, and osteoporosis. Chronic inflammation, which can include radical (pro-oxidant) formation, and cytokine production, is often an underlying cause of these diseases. There is no doubt that consumers now recognize that there exist a direct link between diet and health.

4.2.3 Beliefs and perceptions and their effect on FFDs choice in relation to health and general wellbeing

A total of 109 respondents had a belief and perception that “too much oil, starch, fatty and sugary foods are not good for our health”. “A belief and perception that fruits and vegetables and natural spices are good for our health” was shared by a total of 46 respondents. Five percent (5%) of consumers’ belief that, “a lot of sugar intake leads to the diabetes”. There were significant differences in respondents beliefs and perceptions that “too much oil, starch, fatty and sugary foods are not good for our health” and “fruits, vegetables and natural spices are good for our health” between the urban and peri-urban respondents ($p < 0.001$). However there were no significant differences among the other beliefs and perceptions with respect to respondents’ location (Table 4.4).

Too much oil, starch, fatty and sugary foods are not good for our health. This was the lead belief and perception shared by most respondents (30.3%) in the study. This is consistent with the findings by Mollet and Rowland (2002) and Young (2000) which reported that consumers who have increased believe that foods contribute directly to their health choose more foods believed to be healthy, more natural and impart positively on health. Large quantities of oil, starch, fatty and sugary foods in the diets have been known to contribute

to increased caloric intake and thus development of some chronic conditions (Dietary Guidelines for Americans, 2005). Aging has been associated with decreased immune and health problem (Drichoutis *et al.*, 2005) thus the belief and perception that some foods are not good for ones' health when aging. A successful long life has been found to depend on many biological strategies to foster cell survival against many pathological stimuli (Ferrari, 2007).

Table 4.4 Beliefs and Perceptions about Foods (N=360)

Belief and Perception	Location of consumer			P-value
	Total	Urban(N=180)	Non - Urban(N=180)	
Belief and Perception	235(65.3)	117(65.0)	118(65.6)	0.912
Too much oil, starch, fatty and sugary foods are not good for our health	109(30.3)	39(21.7)	70(38.9)	<0.001*
Some foods are not good for one's health when aging	16(4.4)	10(5.6)	6(3.3)	0.306
Fruits , vegetables and natural spices are good for our health	46(12.8)	35(19.4)	11(6.1)	<0.001*
Natural/ organic foods are good for our health than processed ones	14(3.9)	12(6.7)	2(1.1)	0.06
Okro causes waist pain and piles	26(7.2)	11(6.1)	15(8.3)	0.415
A lot of sugar intake leads to diabetes	18(5.0)	11(6.1)	7(3.9)	0.333
Plantain is healthy since it is rich in iron among the tubers	7(1.9)	6(3.3)	1(0.6)	0.057
Other beliefs and perception	68(18.9)	28(15.5)	40(22.3)	0.109

Other beliefs and perceptions include: moderation is what matters; foods such as snails, pork and eggs are taboos to some people according to religion, ethnic group or physiological conditions; red oil is healthier than vegetable oil; belief that lifestyle and diet is directly related to health.

P-value ((Pearson's Chi-square for categorical variables), Statistical significance at $P < 0.05$

P-values with * means statistically significant

Beside the potential impact of knowledge, beliefs clearly play a crucial role as determinants of food or food product acceptance. The relationships between beliefs in functional foods have been studied in most studies. These range from “belief in one’s own impact on personal health which is related to healthy food choices (Hilliam, 1998)”, “health benefit belief; that is the potential health benefit believed to obtain from the food (Childs, 1997)”, “perception of health claims (Bech-Larsen and Grunert, 2003)”, “belief in the disease-preventative nature of natural foods”; and “opinions of the relationship between food and health; as well as respondents linking certain foods to decreased health (Niva, 2000)”. A number of respondents from the study equally shared in most of these beliefs and perceptions. These included beliefs and perceptions such as “okro cause waist pain”, a lot of sugar leads to diabetes and “plantain is rich in iron”. These however call for concerns as consumers need to be cleared on some of the information available to them from non- scientific based sources and individuals.

There was a belief that fruits, vegetables and natural spices are good for one’s health. In the USA, a similar studies by Childs and Poryzees (1998) reported that half of Americans (55%) believed that naturally occurring substances found in fruits, vegetables and cereal grains can help prevent disease (Urala, 2005). The USDA and U.S. Department of Health and Human Services (2010) reported that diets high in fruits and vegetables are widely recommended for their health-promoting properties. According to them, fruits and vegetables have historically held a place in dietary guidance because of their concentrations of vitamins, especially vitamins C and A; minerals, especially electrolytes; fiber and more recently phytochemicals, especially antioxidants. Viuda-Martos *et al.*, (2010) reported that spices play important role by providing the individuals with extra antioxidants that prevent the appearance of physiological and metabolic alterations. Thus this belief and perception by consumers is of great concern.

4.2.3.1 Effect of Beliefs and Perception on Food Choices

About 38.9% and 34.7% of the urban and peri-urban respondents respectively admitted that, the stated beliefs and perceptions never affects their food choices in general including FFDs. However 23.9% of the urban respondents admitted having been often affected by the beliefs and perceptions. Significant differences were found in the effects of beliefs and perception of on food choices in general ($p=0.003$) (Figure 4.2).

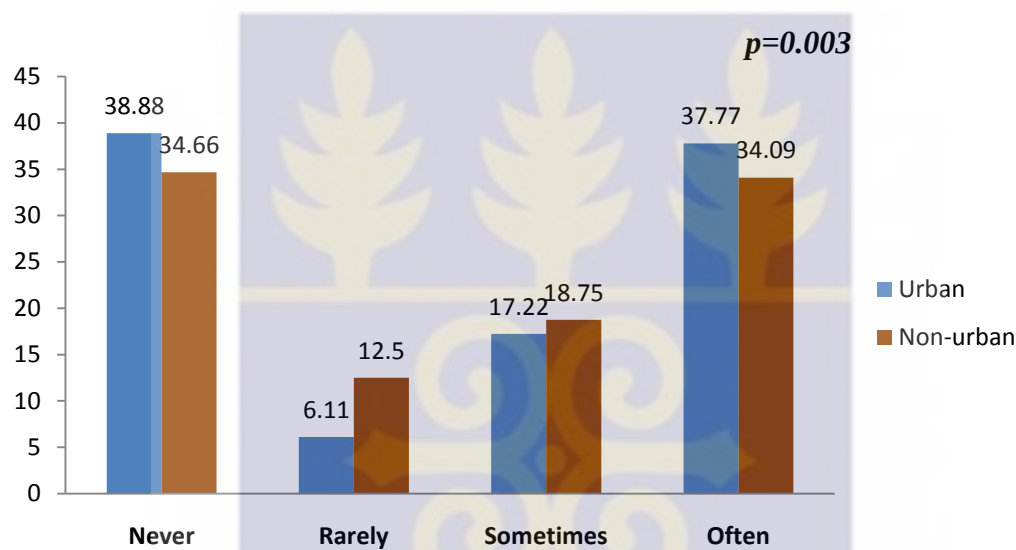


Figure 4. 2 Effect of beliefs and perceptions on food choices by location

Most respondents from both urban and peri-urban locations admitted having not been affected by any of the beliefs and perceptions. For predicting choices of functional food according to Urala and Lähteenmäki (2003), personal attitudes and beliefs of consumers are important. As Wansink *et al.* (2005) also points out: “to consume a functional food, people need to know ‘what’ and ‘why’” for this reason without specialized knowledge, a consumer is likely to only buy functional foods occasionally, reflecting random fluctuations in his or her buying behaviour rather than a consistent preference towards functional foods.

4.2.4 Source of Information by Consumers

A little above halve of the respondents for both urban (56.7%) and peri-urban (54.4%) locations access information from their families and friends. The media constitute the most source of information by both urban and peri-urban respondents; a total of 127 and 126 respectively. A total of 49 out of the 51 respondents who access information from the internet were all urban respondents. About four and a half percent (4.2%) of the respondents access information from the church, vehicles and club associations. There were significant differences between information source from “book, magazines and schools”, “internet” and “hearsay” with respect to location of respondents while the other source of information were not significantly different ($p > 0.05$) (Table 4.5).

Table 4.5 Source of Information by Consumer on FFDS (N=360)

Consumer Source of Information On FFDS	Total (%)	Location of consumer		P-Value
		Urban N=360	Non -Urban N=360	
Family /friends	200(55.6)	102(56.7)	98(54.4)	0.671
Hospital	158(43.9)	75(41.7)	(83(46.1)	0.396
Media	253(70.6)	127(70.6)	126(70.0)	0.604
Book, Magazine and school	87(24.4)	75(41.6)	12(6.7)	0.607
Internet	51(14.2)	49(27.4)	2(1.1)	<0.001*
Hearsay	51(14.2)	35(9.7)	16(4.4)	0.004*
Church, Vehicle and Clubs	15(4.2)	7(3.9)	8(4.4)	0.792

P-value ((Pearson’s Chi-square for categorical variables) Statistical significance at $P < 0.05$
P-values with * are significantly different

The finding in this study is consistent with a study in Malaysia by Teck-Chai *et al.*, (2013) where most Malaysians’ were found to have some knowledge of traditional wellness and

herbal medicines, usually passed down through generations by family and friends. Other information sources included the hospital, media, internet, books, magazines and school, churches, clubs, public transports and “hearsays”. The media being the most information source on FFDs from the study could be attributed to the easy access to radios, T.V and other print media that devote programmes and pages for public educations on healthy eaten. “I watch mother Diana on T.V and listens to “Oheneba” on radio all the time; they teach us how diet is related to our health” admitted by some respondents during the face to face interviews. Communication of the health benefits of foods and for that matter FFDs according to the European Commission report of Functional Foods (2010) should lean on sound scientific evidence. Access to information by some respondents from the hospital was mainly during pre and anti natal care and individuals having some disease conditions who happened to have been referred to dieticians. To make information sources more reliable, it should be in clear and understandable terms and from independent authorities’ and nutrition specialists (Urala *et al*, 2011). Access to information from internet was significantly different among urban and peri-urban dwellers. Higher educational level coupled with easy access to internet and other search tools could account for the difference observed. Recent evolution of increased information technology especially in the urban centres as well as social media may also create avenue for information on these FFDs.

4.2.4.1 Level of Trust in Information Source

The hospital was most strongly trusted information source by respondents (89.1%) followed by the family and friends (74.4%) (Figure 4.3). This finding is consistent with that by Urala *et al*, (2011) where generally, the Food and Drug administration (FDA), health associations and dieticians were the most trusted sources of information for functional food purchasing (28, 24, and 20)% of the respondents, respectively. This could

again be attributed to the presence of experts at the hospital to give information concerning healthy diets and foods to consumers. The internet was moderately trusted (52.7%). Close to about half (47.1%) of the respondents admitted not trusting information from “hearsay” (Figure 4.3). Information from “family and friends”, “books magazines” and school, as well as the “church, public transport and club associations” were also strongly trusted while the internet was moderately trusted.

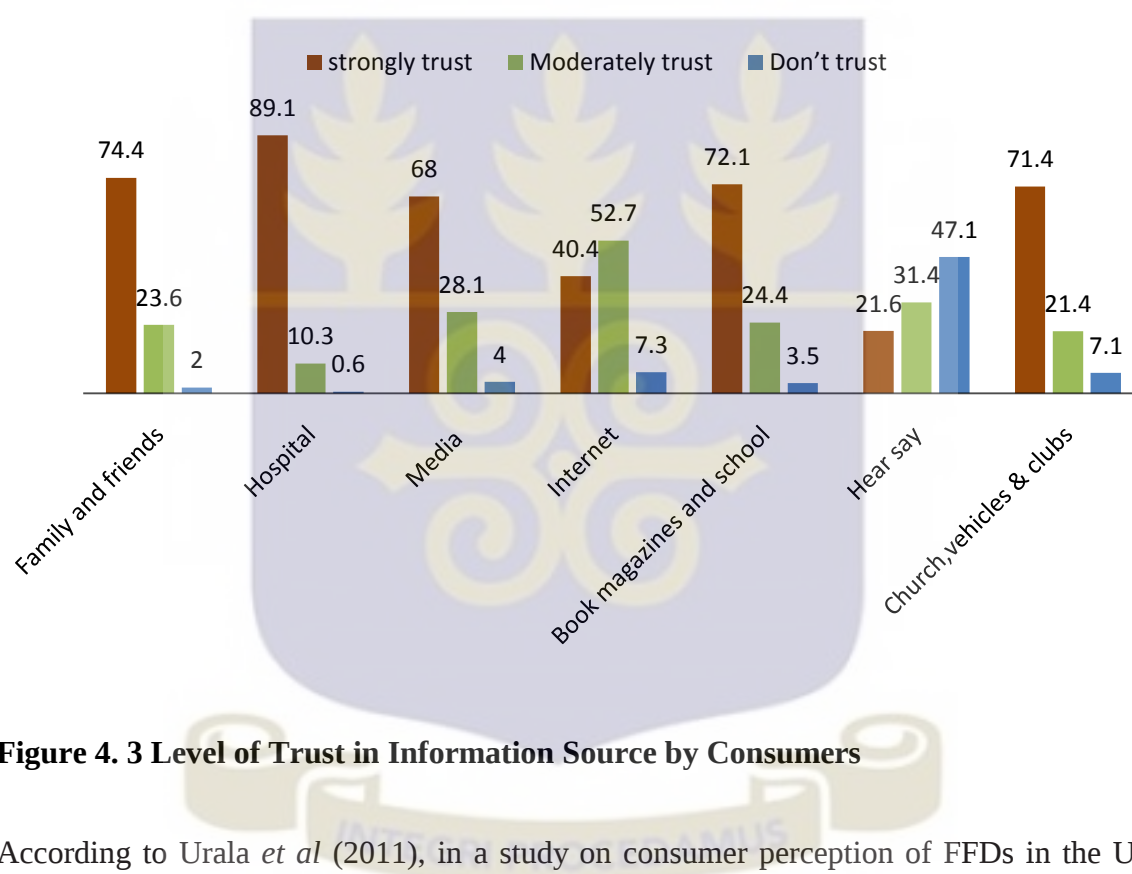


Figure 4. 3 Level of Trust in Information Source by Consumers

According to Urala *et al* (2011), in a study on consumer perception of FFDs in the US, food producers, food retailers and media together were considered less trustworthy information source by respondents. It should also be noted that the type of health-related information and the degree of trust in the information play an important role in acceptance of functional foods (Krystallis *et al.*, 2008). According to Tuorila and Cardello (2002), information on health benefits of a food can increase the likelihood of its consumption. Consumers' knowledge through the right information source also significantly influences

the confidence in functional foods and eventually buying the product (Krystallis et al., 2008).

4.2.5. Prevalence of Disease Condition of Consumer or Family/ Household Member

High blood pressure (hypertension) was the most prevalence for both respondents member of their household (16.4%) and (21.9%) respectively. The prevalence of diabetes and hypertension were high among urban respondents than the non urban respondents. There were a total of 15 out of 18 diabetetic and 45 out of 59 hypertensive respondents respectively for the urban respondents. Stroke was prevalence among family and household member of respondents than consumers themselves (2.5%) and (0.6%) respectively. With respect to location, there were statistically significant differences for the prevalence of diabetes, hypertension, ulcer and asthma for both respondents and/ or family and household members ($p < 0.05$) (Table 4.6). The main strategies adopted by respondents to control/ manage conditions were mainly diet and lifestyle modification (Figure 4.4).

The study found high blood pressure (hypertension) to be the most prevalent disease condition among respondents as well as for their families / household member. Diabetes was also high among respondents especially the urban dwellers. Health consciousness and preventative health behaviour according to Pferdekeamper (2003) are positive influencers on functional food acceptance apart from knowledge. Thus it could be said that respondents who were more aware of their condition are likely to accept and use FFDs. There were also the prevalence of other conditions such as stroke, ulcer, eye problem and asthma among respondents.

Table 4.6 Prevalence of Disease Condition of Consumer or Family/ Household Member (N=360)

Disease Condition Of Consumer, Family/ Household Member	Total	Location of consumer		P-value
		Urban N=180	Non – Urban N=180	
Diabetes (consumer interviewed)	18(5.0)	15(8.3)	3(1.7)	0.04*
Diabetes (household or family members)	44(12.2)	34(18.9)	10(5.6)	<0.001*
Hypertension (consumer interviewed)	59(16.4)	45(25.0)	14(7.7)	<0.001*
Hypertension(household/family member)	78(21.9)	47(26.6)	31(17.3)	0.049*
Stroke (consumer interviewed)	1(0.6)	1(0.6)	0(0)	0.357
Stroke (family/ household member)	9(2.5)	4(2.2)	5(2.8)	0.736
Cancer (consumer interviewed)	0(0)	0(0)	0(0)	<0.001*
Cancer (family/ household member)	0(0)	0(0)	0(0)	<0.001*
Ulcer (consumer interviewed)	0(0)	0(0)	0(0)	<0.001*
Ulcer (family/ household member)	1(0.3)	0(0)	1(0.3)	0.317
Eye problem (consumer interviewed)	0(0)	0(0)	0(0)	<0.001*
Eye problem (family/household member)	2(0.6)	2(1.1)	0(0)	0.156
Asthma (consumer interviewed)	4(1.1)	4(2.2)	0(0)	0.044*
Asthma (Family or household member)	2(0.6)	2(1.1)	0 (0)	0.156

P-value ((Pearson's Chi-square for categorical variables) Statistical significance at $P < 0.05$

P-values with * means statistically significant

ROS (reactive oxygen species) produced in the foods people consume every day have been found to induce undesirable reactions like oxidation of lipids, proteins, nucleic acids, and carbohydrates and are involved in almost 100 diseases such as neurodegenerative disorders, stroke, pancreatitis, diabetes, some cancers, and aging (Verbeke, 2005). It could be said that prevalence of disease conditions among respondents is linked directly or indirectly to diet. Oxidation of carbohydrates and lipids from a diet rich of these nutrients have for instance been associated with the development of diabetes (Ferrari, and Torres 2003). Significant differences were found between urban and peri-urban respondents for

prevalence of diabetes, hypertension, cancer, eye problems and asthma. Walker (1995) equally reported that, differences in health and ill-health mostly depicted between rural and urban dwellers are related to differences in environmental factors, especially diet.

Urbanization has rapidly and substantially changed the circumstances, livelihoods and lifestyles of people in increased reliance on imported foodstuffs, as well as changes in cultural norms and influencing contemporary diets in Southern Africa over the past few decades (FAO, 2008). Strategies adopted by respondents to control/manage some conditions were basically diet modification; less oil, salt, sugar and starch, intake of more herbs, fruit and vegetables, natural spices as well as change in lifestyle; no alcohol, smoking, and more physical activity (Figure 4.4). The findings by FAO could be related to Accra city; for that matter the urban populace where urbanization is on the increase and food consumption trend has changed drastically. There is more out of home eating, sedentary lifestyle, less physical activity among others and on the extreme poor food choices by the rural and urban migrants who come to the city with the expectation of securing jobs (United Nations Human Settlements Programme (UN-HABITAT), 2009) leading to increase diseases among consumers. Therefore a modification in lifestyle and diets could be seen as a means to increase wellbeing and reduce the effect of these diseases in affected individuals.

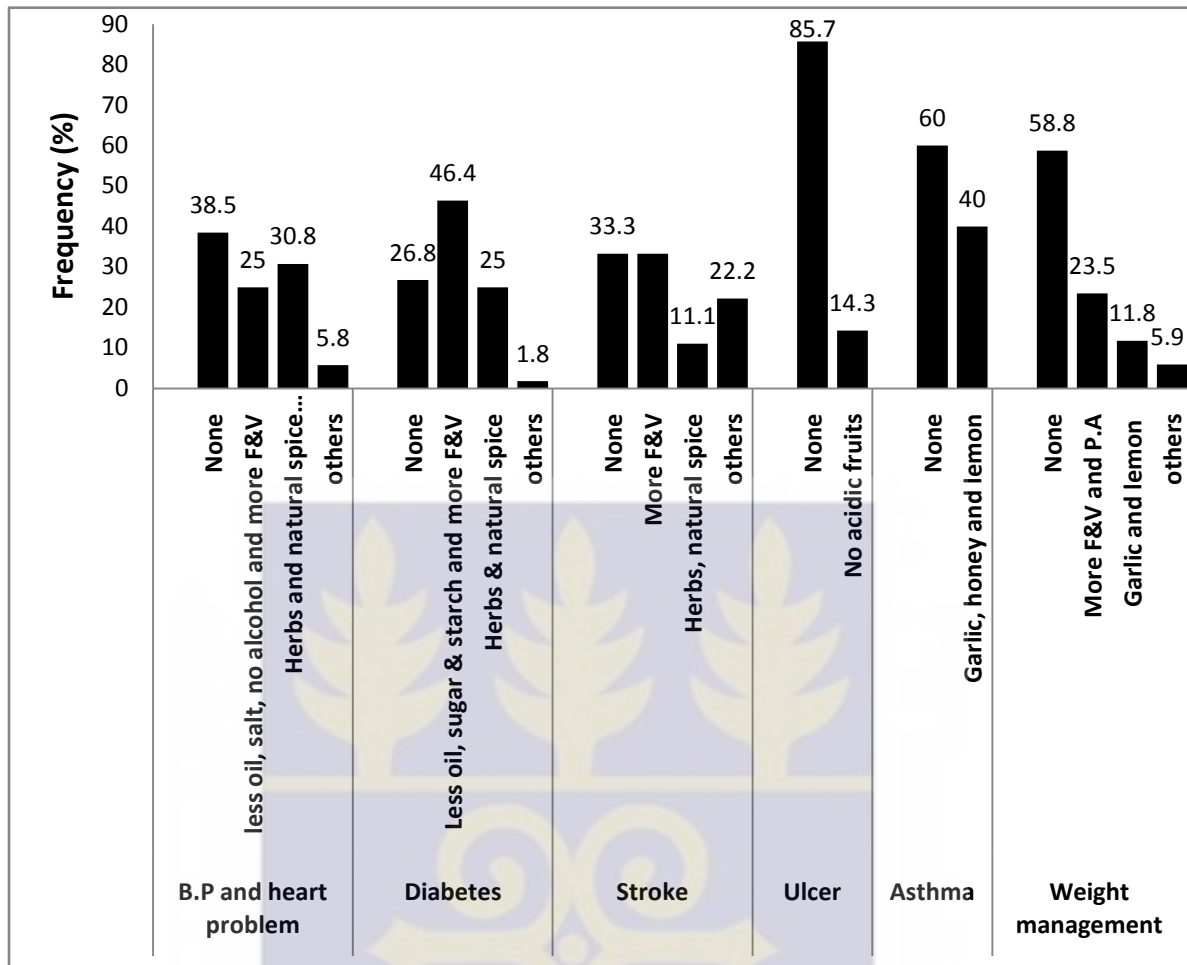


Figure 4. 4: Strategies and food commodities used to manage disease conditions by consumers

F&V: Fruits and Vegetables, P.A: Physical activity, Others include non-dietary strategies

4.2.6 Determinants and impellers to the use of FFDs

4.2.6.1 Fears and Challenges with the Use of FFDs

A total of 225 respondents did not express any fears concerning the use of FFDs. Most respondents gave the reason of “excessive use of agrochemicals and poor agronomic practices” (47.1%) as the most important reason for fear concerning the use of FFDs while “seasonality and price” was the most faced challenged by respondents (21.2%) by both urban and peri-urban consumers with 16.7% and 25.7% respectively. With the exception of challenges faced by respondents there was no significant differences among urban and

peri-urban respondents for fears and the reason for the fears about the use of FFDs ($p>0.05$) Table 4.7.

Table 4.7 Fears and challenges about the use of FFDs and Reasons (N=360)

Fears and reasons about the use of FFDs	Location of consumer			P-value
	Total	Urban	Non – Urban	
Fears about the use of FFDs				0.744
Yes	135(37.5)	66(36.7)	69(38.3)	
No	225(62.5)	114(63.3)	111(61.7)	
Reasons for fear				0.397
The excessive use of agro chemicals (fertilizers and insecticides) & poor agronomic practices	65(47.1)	35(51.5)	30(42.9)	
Dosage, safety and the right time and mode to take some of these foods	14(10.1)	7(10.3)	7(10.0)	
Toxicity and allergic reactions	46(33.3)	22(32.4)	24(34.3)	
Others ¹	13(9.4)	4(2.8)	9(12.8)	
Challenges with the use of FFDs				<0.001*
None	113 (31.5)	65 (36.1)	48(26.8)	
Availability, Seasonality and price	49 (13.6)	14 (7.8)	35 (19.6)	
Seasonality and price	76 (21.2)	30(16.7)	46 (25.7)	
Taste and smell	24 (6.7)	14 (7.8)	10 (5.6)	
The right amount to take at a time	5 (1.4)	2 (1.1)	3 (1.7)	
The time to prepare these foods	6 (1.7)	6 (3.3)	0 (0)	
The good preservation methods	3 (0.8)	2 (1.1)	1 (0.6)	
Availability and seasonality	43 (12.0)	27 (15.0)	16 (8.9)	
Availability and taste	7 (1.9)	5 (2.8)	2 (1.1)	
Availability, price, dosage and time	28 (7.8)	10 (5.6)	18 (10.1)	
Others ²	5 (1.4)	5 (2.8)	0 (0)	

Others¹ includes the fear of allergic reactions and side effects

Others² includes mode of sale, low level of awareness of some FFDs and allergic reaction to some fruits

P-value ((Pearson's Chi-square for categorical variables) Statistical significance at $P < 0.05$

P-value with * means statistically significant

Most respondents reported not having any fears with the use of FFDs for both urban and peri-urban dwellers. Excessive use of agrochemicals leading to high pesticide residue coupled with poor agronomic practices, the right dosage, mode and safety as well as toxicity and allergic reactions were however reported by some respondents as a fear.

Pesticides may be used in a variety of different ways during the production of food. They may be used by farmers to control the growth of weeds or prevent crop damage by insects, rodents and moulds (Cornell University Program on Breast Cancer and Environmental Risk Factors in New York State). Hou and Lu (2010) also reported that agricultural safety and the resulting environmental and health problems from pesticide application are increasingly attracting global attention. (Cooper and Dobson, 2007; Dinham and Malik, 2003; Leyk, Binder, and Nuckols, 2009).

Pesticide residues as reported by Hou and Lu, (2010) affect human health and have become a great threat in that several studies have shown that, the long-term low-dose exposure to pesticides lead to the development of respiratory diseases such as asthma (Hoppin *et al.*, 2002), reduced sperm quality and sperm count, causing sterility (Tuc *et al.*, 2007) and may even affect the human endocrine and immune system. Other scholars also agree that pesticides may promote the development of cancer. Pesticide poisoning is more significant in developing countries compared to developed countries (Hou and Lu, 2010).

Quality and safety are two important elements in consumer food perceptions and decision making associated with food choice (van Rijswijk and Frewer, 2008). According to Anderson (2009), there exists an estimate of less than 1 to 2% of the general population worldwide who suffer from food allergies; the prevalence and adverse effect is unknown thus leading to public perception of the importance of allergic reactions. Some studies have again confirmed the allergic symptoms to melon and bananas by some patients (Anderson, 2009).

4.2.6.2 Factors Influencing FFD Choice and Willingness of Consumers to Use FFDs

Health benefit of the food commodity and product was the most considered factor by respondents when choosing FFDs (90.3%). A little above half (52.8%) of the peri-urban respondents consider the “price” of the food commodity / product when choosing FFDs. About sixty seven-percent (66.1%) of the respondents were willing to pay extra money for FFDs. Majority of respondents were willing to try other FFDs provided the health benefits are well understood (88.3%). The most cited reasons to try other FFDs were “to be convinced whether it is good for one’s health” (31.2%) and “to be healthy and live longer” (24.5%). A total of 19 out of 23 urban respondents were only willing to try other FFDs if they are used to it. The fear of allergic reaction was also cited as a reason not to try other FFDs (3.9%). With the exception of health benefits and sensory attributes there were significant differences with respect to location of the respondents for the other determinants and impeters to the use of FFDs ($p < 0.05$) (Table 4.8).

Several factors were found to influence functional food choices by consumers which included the health benefit, sensory, price, brand among others as well as their willingness to try other FFDs. Hedonic properties such as taste, flavour, texture, mouth feel among others according to Tuorila *et al.*, (2002) and Verbeke, (2005) strongly drive the choices of functional foods. Martijin and Nicole (2004), reported that the 1970s saw an upsurge of ‘natural’ and ‘organic’ foods, and the 1980s saw the introduction of ‘low’ and ‘light’ foods with less calories, cholesterol, or salt. Though not all of these foods were palatable, consumers were willing to make sacrifice because at that time, eating for long-term prevention of disease fitted the prevailing mood. Urala and Lahteenmäki (2004) however indicated in a similar study that, some products may have such a strong health claim that consumers are always ready to compromise on taste.

Table 4.8 Factors influencing FFD choice and willingness of consumers to use FFDs (N=360)

Factors affecting FFDs choice/ willingness to use FFDs	Total	Location of consumer		P-value
		Urban N=180	Non -Urban N=180	
Health benefit	325 (90.3)	167 (92.8)	158 (87.8)	0.109
Sensory	197(54.7)	93(51.7)	104 (57.8)	0.244
Price	162(45.0)	67 (37.2)	95 (52.8)	0.003*
Convenience of usage	78 (21.7)	63 (35.0)	15 (8.4)	<0.000*
Other ¹ reasons for usage	19 (5.3)	14 (7.8)	5 (2.8)	0.035
Would you be willing to pay extra	238 (66.1)	151 (83.9)	87 (48.3)	<0.001*
Willingness to try other FFDs	318 (88.3)	150(83.3)	168 (93.3)	0.003*
Reason to try FFDs				<0.001*
To add to the ones I know and be more healthy; no one knows it all	54 (15.0)	19 (10.6)	35 (19.6)	
You experts know better	32 (8.7)	20 (11.1)	12 (6.7)	
To be more healthy and live longer	88 (24.5)	60 (33.3)	28 (15.6)	
To be convinced whether it is good for y health	112 (31.2)	41 (22.2)	71(39.7)	
If I am not used to it I will not try it	23 (6.4)	19 (10.6)	4 (2.2)	
I may react to it (allergic)	13 (3.9)	9(5.0)	4(2.3)	
If it is safe and approved	17 (4.7)	11 (6.1)	6 (3.4)	
Others ²	21 (5.8)	1 (0.6)	20 (11.2)	

Others¹ includes, ease of preparation, safety, side effects and the health claims

Others² includes; reasons of aging, health been a priority, no harm in trying, if the information is from a qualified personnel, if the food taste good, I am not sick; I won't try any, to manage my excessive weight gain.

Statistical significance at $P < 0.05$

P-value with * means statistically significant

Ares *et al.*, (2008) reported similar findings in a study where, consumers with low level of nutritional knowledge, particularly knowledge related to the health consequences of diet

were not interested in consuming functional; less willing to try FFDs and vice versa. Price was also considered as the third important food purchasing criteria in a study by Saheli *et al.*, (2014) among Iranian consumers and thus assumed to be a key determinant of FFD acceptance by consumers. The difference in price as a determinant to the use of FFDs by consumers among the urban and peri-urban dwellers could thus be linked to the differences in profession and eventually the income levels of respondents in these two locations. Seasonality of some FFDs especially fruits and vegetable also have the tendency to affect the price. A lot of researchers conclusively reported that economic factors such as price, availability, and income influence the actual consumption and the use of foods in general with regard to what and how much is chosen. However, preference is always a priority to the consumers.

4.2.7 Nutrients Supplements Use

The urban respondents were found to have high nutrient supplement usage with a total of 36 out of 65 respondents. Sixty percent (60%) of the respondents specifically take B-complex and Multivitamin supplements. Blood tonic usage was found mostly among the peri-urban respondents while synthetic nutrient supplement use was higher for the urban respondents. The most reason cited for supplement usage was “to boost the body immune and for general wellbeing”. Significant differences were found within the specific supplement usage and the reason for supplement use with respect to location of respondents ($p < 0.001$) (Table 4.9).

Nutrient supplement was used by some respondents as a means to boost their immune and to improve nutrient adequacy especially vitamins and minerals. A study in the US reported that nearly 50% of the U.S. adult population reported using supplements. This is similar to findings by Betts and Rezek (2008), where vitamins especially C and E were the most commonly used supplements. The voluntary use of nutritional supplements among

populations could contribute to improved nutrient density of the diet, and thus reduce the prevalence of micronutrient deficiencies where they exist (Mejía-Rodríguez *et al*, 2007). However concern has also been raised about the possible risk of toxic effects from chronic, excess nutrient intakes because of voluntary supplement use. The urban consumers again have access to several other sources and means of complex synthetic nutrient supplement and thus the differences in specific nutrient supplement use among urban and peri-urban consumers.

Table 4.9 Nutrients Supplement Use and Reasons for use

Nutrient supplement use	Total	Location of consumer		P-Value
		Urban (N=180)	Non-urban (N=180)	
Do you take in any nutrient supplements	65 (18.1)	36 (20.0)	29 (16.1)	0.337
Specific supplement				<0.001*
B-complex and multivitamins	39 (60.0)	23 (62.2)	16 (57.1)	
Blood tonic	11 (39.3)	0 (0)	11 (16.9)	
Wellman/ Well woman	3 (4.6)	3 (8.1)	0 (0)	
Mineral supplements	2 (3.1)	2 (5.4)	0 (0)	
Essential oils, cod liver, olive	2 (3.1)	2 (5.4)	0 (0)	
Other ¹ synthetic nutrient supplement	8 (12.3)	7 (18.9)	1 (3.6)	
Reason for supplement use				<0.001*
To boost my immune and general wellbeing	18 (29.5)	17 (45.9)	1 (4.2)	
To supplement my blood level	16 (26.2)	5 (13.5)	11 (45.8)	
To supplement the nutrients that are lacking in my diet	15 (24.6)	11 (29.7)	4 (16.7)	
To manage my disease condition as prescribed by my doctor	2 (3.3)	2 (5.4)	0 (0)	
Others ²	10(16.4)	2 (5.4)	8 (33.3)	

Blood tonic includes liquid mixture and syrup prepared traditionally or synthetically to boost blood formation in the body.

Others¹ synthetic supplement include; TR`EVO, Every Man/Woman, Herbal life, Forever living, Neo vita, Tre-en-en supplement, Garlic Capsules, Glucosamine supplement and one-a-day woman supplement.

Other² reason for supplement use include; to be healthier, to lose weight, to boost sexual functions.

Statistical significance at $P < 0.05$.

P-value with * means statistically significant.

4.2.8 Associations between Specific Variables and FFDs

The specific variables considered were socio demographic variables (gender, age and level of education), consumer information source, prevalent diseases among consumers (diabetes, hypertension and stroke) and nutrient supplement use. Frequency of usage was obtained from composite scores of the usage of the top ten (10) FFDs (Figure 4.5).

4.2.8.1 Association between Gender, Age & Level of Education and Consumers Awareness and Willingness to Try or Pay Extra Money for FFDs

Table 4.10 shows that with the exception of consumers' willingness to pay extra money for FFDs, there were no significant association between awareness and willingness to try FFDs and gender of consumer. Majority of both males and females respondents were aware of FFDs at 96.37% and 95.49.6% respectively. More males were willing to pay extra money for FFDs than females (72.5% and 62.2%). Awareness of FFDs was high across all age groups (> 90%).

Awareness and willingness to try functional foods was not significantly associated with gender. This finding is consistent with that reported by Wardle *et al.* (2000) stated that several studies found association between increased nutritional knowledge and FFDs choices regardless of gender. Verbeke (2005), on the contrary reported that female respondents reported a significantly higher perceived importance of food for health (FFDs) as compared to men in two separate studies (2001) and (2004) which was consistent with literature reporting a stronger health-orientation for food among females. Young, (2000), and Mollet and Rowland (2002), have reported that , functional foods benefits have been so publicized through research that, consumers now believe that foods contribute directly to their health. This might have accounted for increased in awareness for both male and female respondents

Table 4.10 Relationship between Gender, Age and Level of Education and Awareness, Willingness to Try and Willingness to try FFDs

Background variable	Awareness of FFDs		p-value	Willing to try FFDs		p-value	Willingness To Pay Extra Money for FFDs		p-value
	Total	Yes	No	Yes	No		Yes	No	
Gender									
Male	138 (100)	133 (96.4)	5 (3.6)	121 (87.7)	17 (12.3)	0.684	100 (72.5)	38(27.5)	0.761
Female	222(100)	212 (95.5)	10 (4.5)	197 (88.7)	25 (11.3)		138(62.2)	84(37.8)	
Age									
18-29	147 (100)	139 (94.6)	8 (5.4)	131(89.1)	16 (10.9)	0.42	91 (61.9)	56 (38.1)	0.023*
30-39	80 (100)	76 (95)	4 (5)	67 (83.8)	13(16.3)		49(61.3)	31 (38.8)	
40-49	42 (100)	41 (97.6)	1 (2.4)	36 (85.7)	6 (14.3)		37 (88.1)	5 (11.9)	
50-59	51 (100)	49 (96.8)	2 (3.92)	46(90.2)	5 (9.8)		33 (64.7)	18 (35.3)	
60 or more	40 (100)	40 (100)	0 (0)	38(95.0)	2 (5.0)		28 (70.0)	12 (30.0)	
Highest level of education									
None	23 (100)	22 (95.7)	1 (4.3)	22 (95.7)	1 (4.3)	0.154	7 (30.4)	16 (69.6)	<0.001*
Primary	37 (100)	35 (94.6)	2 (5.4)	35 (94.6)	2 (5.4)		14 (37.8)	23 (62.2)	
JHS/ Middle school/ Form 4	115 (100)	111 (96.5)	4 (3.5)	104 (90.4)	11 (9.6)		70 (60.9)	45 (39.1)	
Vocational / Technical/ commercial	27 (100)	26 (96.3)	1 (3.7)	25 (92.6)	2 (7.4)		23 (85.2)	4 (14.8)	
Secondary/A&O									
Level/six form	54 (100)	54 (100)	0(0)	48 (88.9)	6 (11.1)		40 (74.1)	14 (25.9)	
Tertiary	74 (100)	71 (95.9)	3 (4.1)	61 (82.4)	13 (17.6)		60(81.1)	14 (18.9)	
Post graduate	30 (100)	26 (86.7)	4 (13.3)	23 (76.7)	7 (23.3)		24 (80.0)	6 (20.0)	

P-value with * means statistically significant

Respondents' willingness to pay extra money for FFDs was high for those within the age group 40 - 49 years. Awareness of FFDs was also high for all respondents across the various educational levels. No formal education of respondents scored low for their willingness to pay extra money for FFDs (30.4%). However an educational level up to vocational, technical or commercial was associated with willingness to pay extra money for FFDs. The age of respondent as well as level of education was not significantly associated with awareness of FFDs and willingness to try except for their willingness to pay extra money for a FFD.

The findings from this study could be said to differ from that of a quantitative study in the US during 1992–1996 which identified the functional food consumer as being female, well educated, higher income class and in a broad 35–55 age group (Childs 1997). However higher income could be associated with respondents' willingness to pay extra for a FFD as was found in the study. The findings could be related to that of De Jong *et al.* (2003) which concluded that functional food use is not legitimately significantly affected by gender, age and education of the consumer and thus should not be generalized. The differences rather depend on functional food or products in question.

4.2.8.2 Association between consumer information source, willingness to try FFDs and frequency of usage of the FFDs

More than 80% of respondents who access information from all the sources considered in this study were willing to try other FFDs (Table 4.11). Significant associations were found between respondents having information from family and friends, media, book magazines and school and willingness to try FFDs ($p < 0.05$). The reverse was observed for information from hospital, internet, church vehicles and clubs and hearsay (Table 4.11). Information concerning the health effects and the means of communicating them according to Annumziata and Vicchio,(2011b) are the key factors behind the success of

the functional foods and product. This may explain why most information sources were associated with willingness to try FFDs and partly due to the high level of trust in such sources by consumers in the study. Usually the health effect of the food or product cannot be perceived directly from the product itself and requires the right people to communicate the information.

About sixty-three percent (62.7%) of consumer who assess information from “hearsay” uses FFDs every day. Significant associations were however not found between the frequency of usage of FFDs and all the information sources except for information from “hearsay” ($p=0.028$) (Table 4.11). The significant association with information from “hearsay” and consumers willingness to try FFDs could be explained by some respondents’ curiosity to try new FFDs. Some respondents admitted from the study that, the reason to try other FFDs was to be convinced whether it is good for their health or not (Table 4.8). In general, it has been established that recognized institutions, associations and experts are the most trusted sources of information for functional food purchasing and consequently its frequency of usage (Urala *et al.*,2011).



Table 4.11 Relationship between information source, willingness to try and frequency of usage of FFDs

Information Source	Total	Willingness to try			Frequency of Usage			
		Yes	No	p-value	Everyday	3 /more/wk	once /wk/ Occasionally	P-value
Family and friends	200 (100)	183 (91.5)	17 (8.5)	0.036*	89 (44.5)	90 (45.0)	21 (10.5)	0.72
Hospital	158 (100)	141 (89.2)	17(10.8)	0.635	64 (40.5)	75 (47.5)	19 (12.0)	1.32
Media	252(100)	227(90.1)	25 (9.9)	0.009*	107(42.4)	115 (45.6)	31 (12.3)	0.074
Books magazine & school	86 (100)	71 (82.6)	15 (17.4)	0.003*	44 (51.2)	36(41.9)	6 (7.0)	0.552
Internet	51 (100)	41 (80.4)	10(19.6)	0.58	30 (58.8)	19 (37.3)	2 (3.9)	0.086
Church, vehicles and clubs	15(100)	14 (93.3)	1 (6.7)	0.538	4 (26.7)	8 (53.3)	3 (20.0)	0.211
Hearsay	51 (100)	44(86.3)	7 (13.7)	0.621	32 (62.7)	17 (33.3)	2 (3.9)	0.028*

P-value with * means statistically significant



4.2.8.3 Association between disease condition awareness and willingness to try FFDs

All respondents who were diabetic were aware of FFDs (100%) and this was same for consumers with stroke. Most diabetic and hypertensive respondents were willing to try FFDs 88.9 % and 89.8 % respectively. There were no significant association between the disease condition of the respondents and awareness and willingness to try FFDs ($P < 0.05$) (Table 4.12).

Table 4.12 Relation between disease condition, awareness and willingness to try FFDs

Disease condition	Awareness of FFDs				Willingness try FFDs		P-value
	Total	Yes	No	P-Value	Yes	No	
Diabetes	18 (100)	18(100)	0(0)	0.364	16(88.9)	2 (11.1)	0.94
Hypertension	59(100)	58(98.3)	1 (1.7)	0.299	53(89.8)	6 (10.2)	0.695
Stroke	1 (100)	1 (100)	0(0)	0.835	1(100)	0(0)	0.716

P-value with * means statistically significant

The study found no significant association between the three most prevalent disease conditions and awareness as well as willingness to try FFDs. Verbeke (2005) on the contrary reported that the presence of an ailing family member or if the consumer encounters a specific health problem, will influence the acceptance of functional foods positively. This is further supported by Childs (1997) who also reported that experience with relatives' loss of good health (family or household member) and associated economic and social consequences have been reported by respondents to act as an incentive to adopt disease prevention food habits given the fact that prevention is a major motivation of functional food use (Wrick, 1995; Milner, 2000b). On the contrary, Pferdekeamper (2003) reported that health consciousness and preventative health behaviour are positive

influencers on functional food acceptance and ultimately its usage, whereas product knowledge was insignificant to FFD use.

4.2.8.4 Association between disease condition and factors influencing FFDs choice

All respondents who were diabetic were influenced by the health benefit of the FFDs (100%). Sensory properties were considered by about forty-one percent (40.7%) of hypertensive consumers. Price of FFDs was considered by 3.7% of respondents who were diabetic while 96.3% of non-diabetic respondents consider the price as a factor influencing FFDs choice. For hypertension, 21 out of the total hypertensive respondents of 59 admitted having considered the price while 87% of non- hypertensive respondents is influenced by the price of FFDs. A percentage of 3.8% diabetic respondents are affected by the convenience of usage of FFDs. There was significant association was found between hypertensive respondents and the influence of sensory benefits of the FFDs (Table 4.13).

Table 4.13 Relationship between Disease condition and Factors influencing FFDs

Disease condition	Factors Influencing FFDS Choice					
	Health benefits		Sensory properties		Price	
	Total	P-Value	P-Value	P-Value	P-Value	P-Value
Diabetes						
Yes	18 (100)	18 (100)	0.153	8(44.4)	0.369	6 (3.7)
No	342 (100)	307 (94.5)		189 (95.9)		156 (96.3)
Hypertension						
Yes	59(100)	57 (96.6)	0.073	24(40.7)	0.018*	21 (13.0)
No	301 (100)	268 (82.5)		173 (87.8)		141 (87.0)
Stroke						
Yes	1 (100)	1 (100)	0.742	1 (100)	0.362	0(0)
No	359(100)	324 (99.7)		196 (99.5)		162 (100)

P-value with * means statistically significant

Acceptance of a FFD is determined by a multitude of factors such as primary health concerns, consumers' familiarity with the functional food concepts and with the functional ingredients, the nature of the carrier product, the communication mode of health effect among others (Verbeke, 2005; Annunziata; Sirò *et al.*, 2008 and Vecchio, 2011). The need by consumers to lower high blood cholesterol levels, high blood pressure and reduce the risk of diabetes, and improve the body's immune system together with improving digestion system were also among the biggest health concerns by consumers when choosing a functional food (Urala, *et al.*, 2011). In that same study by Urala *et al.*, (2011) consumers who admitted not even being familiar with the term functional foods were aware that whole wheat cereals, vegetable juice, carrots, toast with high fiber and green tea had special health benefits and thus were frequently used. Thus the awareness and the perceived health benefits continue to drive the use of a functional foods and products. According to Sääksjärvi *et al.* (2009), increased awareness and knowledge on functional foods continue to justify the payment of higher price by consumers. Thus whether diseased or not, consumer may be willing to pay extra for a FFD but may be considered at times. A lot of researchers conclusively report that economic factors such as price, availability (relation to convenience of usage and ease of preparation), and income influence the actual consumption and the use of foods in general; "what" and "how much" is chosen.

4.2.8.5 Association between Disease condition and frequency of usage of FFDs

Functional food usage was not significantly associated with specific disease conditions of respondents (Table 4.14). About forty- four and a halve percent (44.4%) of diabetic respondents uses FFDs every day while 50.8% of hypertensive consumers use FFDs three of more times a week. Table 4.14 Relationship between Disease condition and usage of FFDs

Disease condition	Total	Usage of FFDs			p-value
		Everyday	3/ more/ wk	Once/ wk or Occasionally	
Diabetes	18 (100)	8(44.4)	7(38.9)	3 (16.7)	0.519
Hypertension	59(100)	23 (39.0)	30(50.8)	6(10.2)	0.416
Stroke	1 (100)	0(0)	1 (100)	0(0)	0.519

P-value with * means statistically significant

The findings could be related to that of Roberfroid, (2000b) and Menrad, (2003) where it was revealed that the intention to eat food today is not to only satisfy hunger and provide necessary nutrients for humans but also to prevent and manage nutrition-related diseases, improve physical and mental well-being of the consumers and may be a driving force to the increase FFD usage regardless of disease condition.

4.2.8.6 Association between nutrient supplement use and the frequency of usage of FFDs

More than halve of the respondents who uses nutrient supplement also uses FFDs everyday (53.8%). About forty-five percent (44.7 %) of respondents that do not use nutrient supplement at least use FFDs every day. There was no significant association between the use of nutrient supplement and the frequency of usage of FFDs ($p=0.386$) (Table 4.15).

Nutrient supplements use according to Eileen, *et al* (2013), is not necessarily skewed toward the ill-health individuals as they improve on the general wellbeing of the user. Jonas and Beckmann (1998) in a study among the Danes in turn, reported that consumers regarded pills and supplements as acceptable resources for balancing their nutritional needs (Urala, 2005). Thus nutrients supplement use may not necessarily be used completely in place of functional foods.

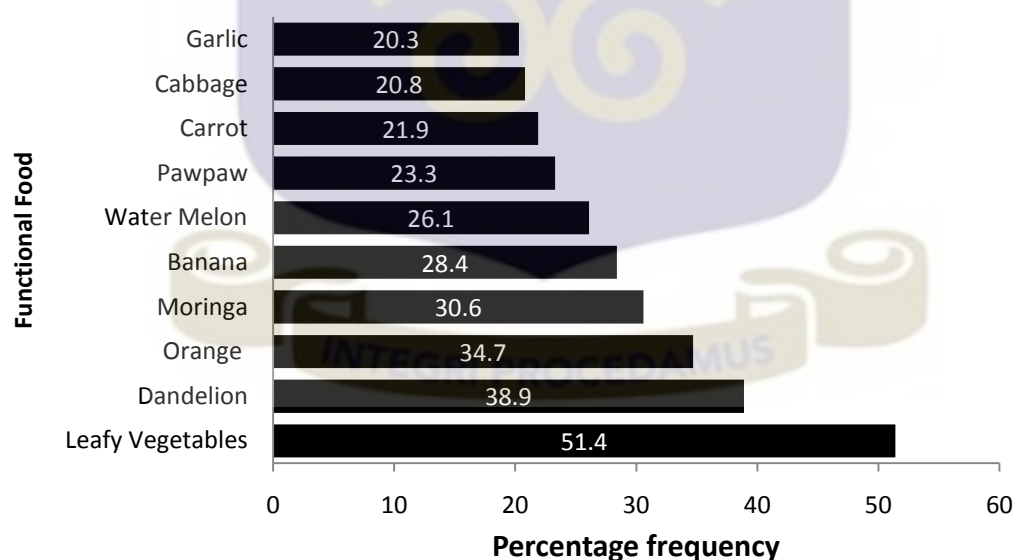
Table 4.15 Relation between Nutrient supplement and FFDs usage

Nutrient supplements use	Usage of FFDs				p-value
	Total	Everyday	3 /more/wk	once /wk/ Occasionally	
Yes	65(100)	35(53.8)	25(38.5)	5 (7.7)	0.386
No	295 (100)	132 (44.7)	131 (44.4)	32(10.8)	

4.2.9 Specific Food Commodities Perceived To have nutraceutical properties

4.2.9.1 The top ten foods perceived to have nutraceutical properties

The top ten FFDs known by respondents included vegetables, fruits and herb spices. Leafy vegetables were the most recognized FFDs (51.2%) by respondents. Garlic was the first spice to be recognized as a FFD commodity (20.3%).

**Figure 4. 5: Frequency (%) of the top ten (10) perceived FFDs**

4.2.9.2 Frequency of Usage of the Top Ten (10) Perceived FFDs

Garlic was mostly used everyday among the top ten FFDs (45.2%) by respondents. For the frequency of 3/more times a week, pawpaw was mostly consumed (61.9%). All ten FFDs were used at least three or more times a week.

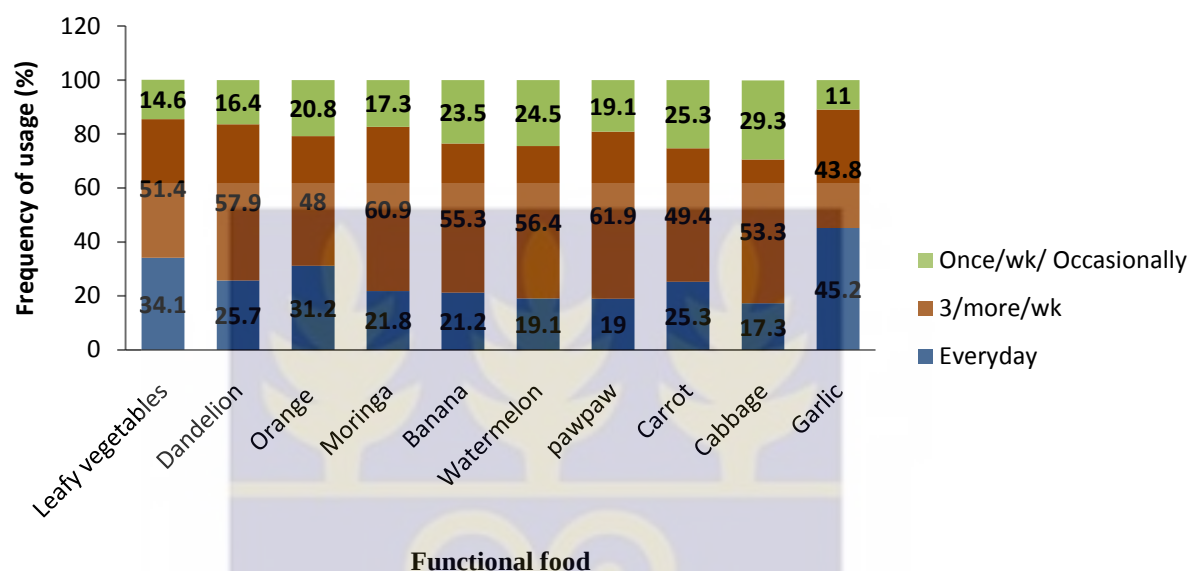


Figure 4. 6: Frequency of usage of the top ten (10) FFDs

The percentage frequency of the first ten FFDs could be associated with knowledge about the FFD. Thus a food was mentioned as functional more frequently because respondents knows about them and is likely to use them as well. Urala, (2005) reported similar observation where most of the example of foods reported as functional were used often and can be considered familiar to the respondents. The findings from the study where all ten most known (perceived) FFDs by respondents were used at least every day by consumers could be identified again with that by Urala (2005) who reported that functional foods may also promote anti-inflammatory conditions and improved wellbeing to the body when you eat them regularly.

4.2.9.3 Fruits perceived to have Nutraceutical Properties

Among the fruits perceived to be functional, orange was the most known by respondents (34.6%) followed by watermelon (26%). The least known fruits were baobab fruits and strawberries, (0.3%) each respectively (Figure 4.7).

Fruits contain glucose, fructose, sucrose and fiber, and are mostly relatively low in calories (Dhanvijay, (2013). In addition, fruits are important sources of at least eight additional nutrients including vitamin C, folate, and potassium which may help control blood pressure. Thus it was not surprising when fruits constituted the most perceived functional food from the survey results. Fruits such as orange, watermelon, pawpaw and mango are most common among Ghanaians thus are likely to be known and used regularly to achieve the perceived health benefits. Grapes, star fruit, baobab fruits and strawberries are not very much known by respondents and thus were less perceived as FFD. There is a belief that adults who increase their fruit and vegetable consumption in adequate quantities are associated with a decreased risk of such chronic diseases as stroke and perhaps other cardiovascular diseases like type 2 diabetes, and cancer in certain sites and may also be useful in achieving and sustaining weight loss .



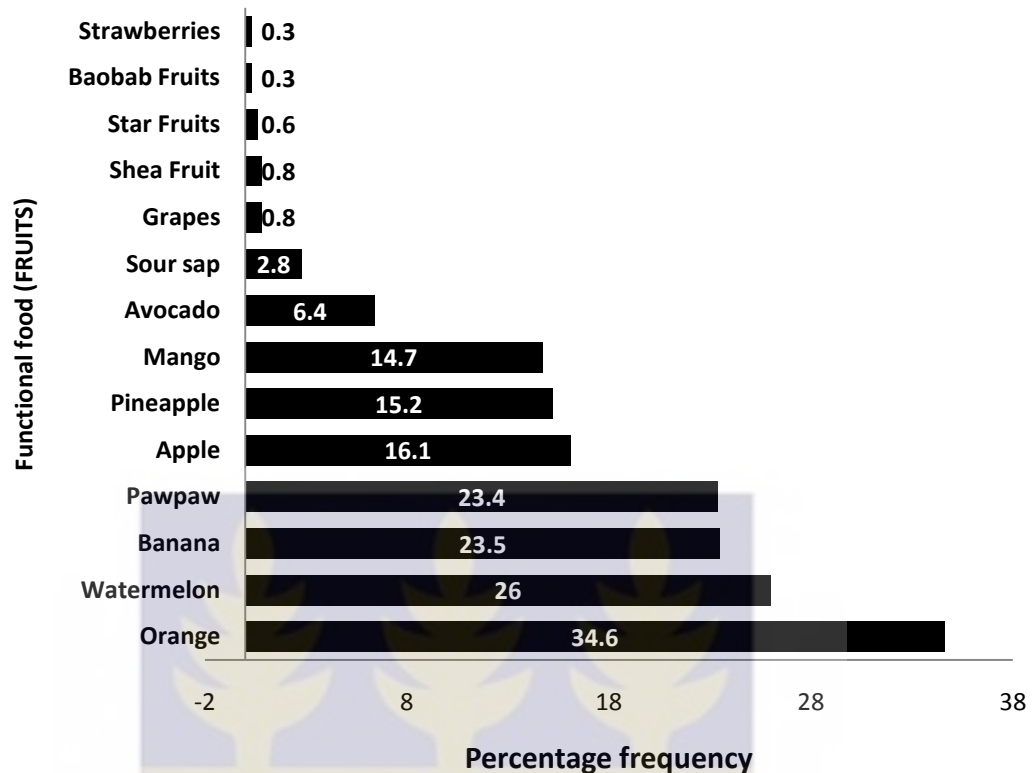


Figure 4. 7: Fruits perceived as FFD

4.2.9.4 Herbs Perceived to have Nutraceutical Properties

Dandelion was the most perceived FFD among the herbs (38.8%) followed by Moringa (30.5%). Noni plant was the least known FFDs among the herbs by respondents. Dandelion and Moringa plants have gained worldwide recognition because of the numerous health roles they play in our bodies. Herbs have been found to play a health roles in immune, reproduction, digestive and cardiovascular health of consumers. Herbs in general have been found to be a natural source of antioxidant and play major health roles in the body (Lee *et al.*, 2005). Bitter leaves *Vernonia amygdalina* is also perceived by most Ghanaians to aid in blood purification and weight management among others. Noni was the least perceived FFD among the herbs and could be associated with the low level of knowledge by respondents on this particular plant (herb) and its health benefit.

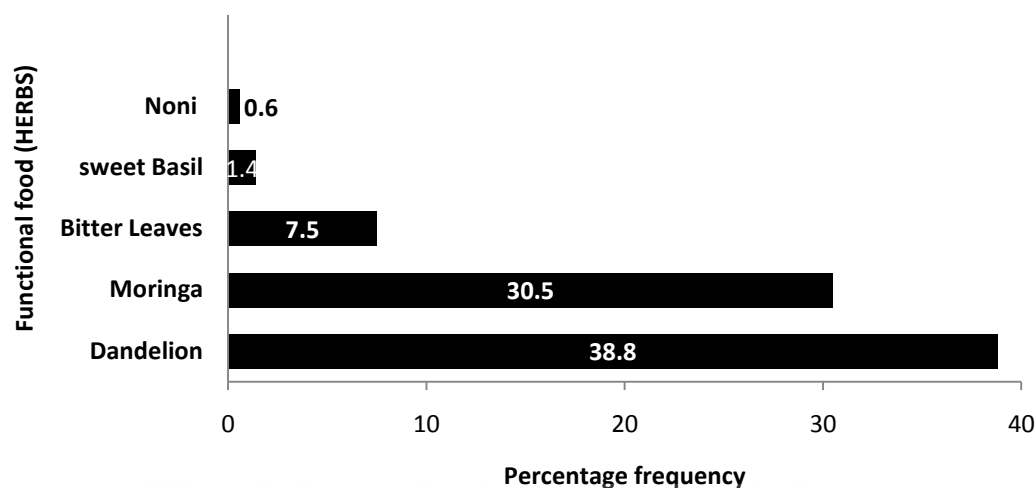


Figure 4. 8: Herbs perceived to as FFD

4.2.9.5 Vegetables Perceived to have Nutraceutical Properties

Vegetables were the second most perceived FFD group by consumers from the survey. They included leafy vegetables, egg plants, bulbs, roots and flowers. Leafy vegetables were the most perceived/known vegetables (51.2%). These includes “gboma”, “kontomire”, “ademey”, “shure”, “alefu”, “spinach” “waterleaf” and lettuce. Coriander, broccoli and aubergine were the least known FFDs among the vegetables. According to Hornick and Weiss (2011), vegetables are also important sources of 19 or more nutrients, including potassium, folate, and vitamins A and E and may provide antioxidant effect to the body. Many vegetables provide only small amounts of sugars and/or starch, some are high in starch, and all provide fiber; thus improving on health and general wellbeing through improved micronutrient adequacy of consumers. They also aid in weight management plans as they increase satiety and reduce the intake of energy dense foods. Weight management continues to be one of the drivers of a reason why consumers would use a functional as was found from the study.

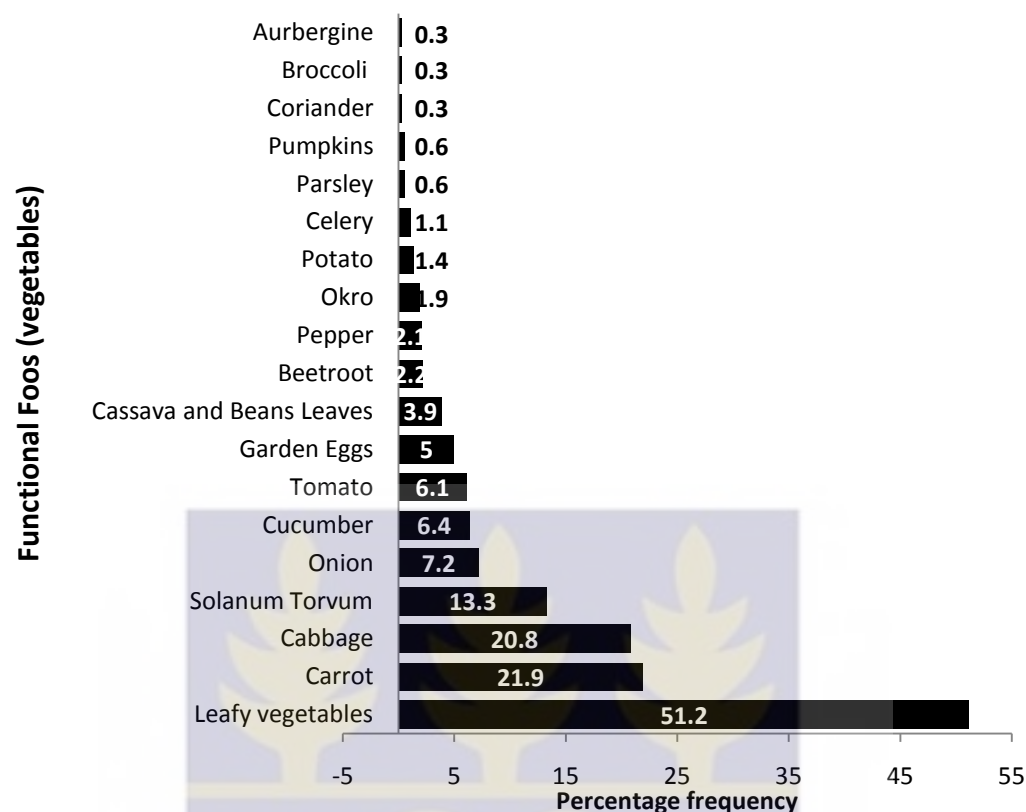


Figure 4. 9: Vegetables perceived as FFD

4.2.9. 6 Drinks Perceived to have Nutraceutical Properties

Coconut water drink was most perceived to have nutraceutical properties (4.4%), while ginseng tea was recognized by 0.3% of respondents as FFD (figure 4.10). Drinks perceived to be functional include teas among other drinks. Dietary sources of phenolic acids according to Landete (2013) include not only fruits, vegetables and other foods but also, tea, coffee and red wine which all fall within this food category. Phenolic compounds have all been found to also have antioxidant activities. Hibiscus drink popularly called “Bissap” according to the Fibre, Food and Beauty for Poverty Reduction Report, is clearly regarded as a health drink in many cultures. It has been, or still used as an antiseptic, aphrodisiac, astringent, cholagogue, demulcent, digestive, diuretic, emollient, laxative, cooler, sedative, and tonic. It is used to treat liver disorders and high blood pressure in Chinese and in East Africa and the infused hibiscus drink called "Sudan tea", is taken to

relieve cough. Soda water, a processed carbonated water has been associated with reduced high blood pressure. Lemon drink has also been linked to fat burning thus contributing to weight control among obese individuals.

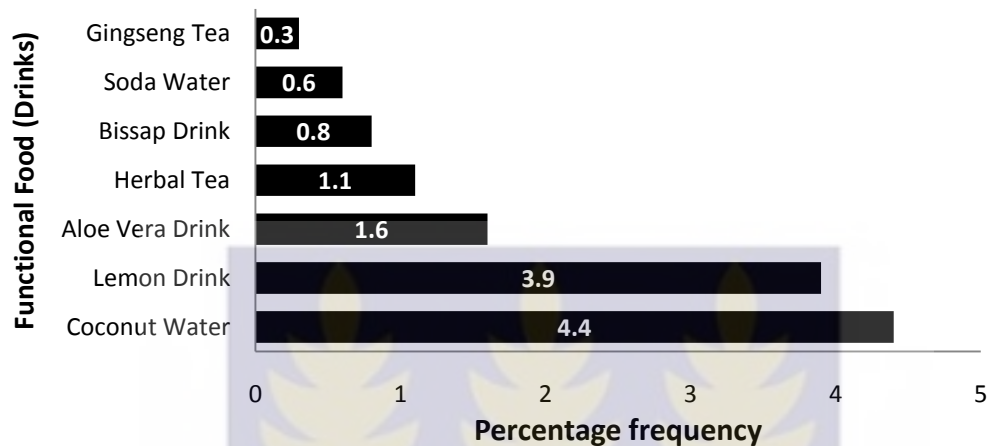


Figure 4. 10: Drinks perceived as FFDs

4.2.9.7 Natural spices Perceived to have Nutraceutical Properties

The natural spices perceived to have nutraceutical properties included garlic and was the highest (20.3%). Thyme was least perceived by respondents as being a FFD (0.3%) (Figure 4.11).

According to Viuda-Martos *et al.*, (2010) spices play a role to impart flavour and reduce the need for salt and fatty condiments, improve digestion, and provide extra antioxidants that prevent the appearance of physiological and metabolic alterations. Thus spices as a category of food also play functional roles in the body and are highly important in the consumers' diet in the attainment of optimum health. Consumers equally associated spices to improved wellbeing, act as antioxidants and for proper cardiac functioning.

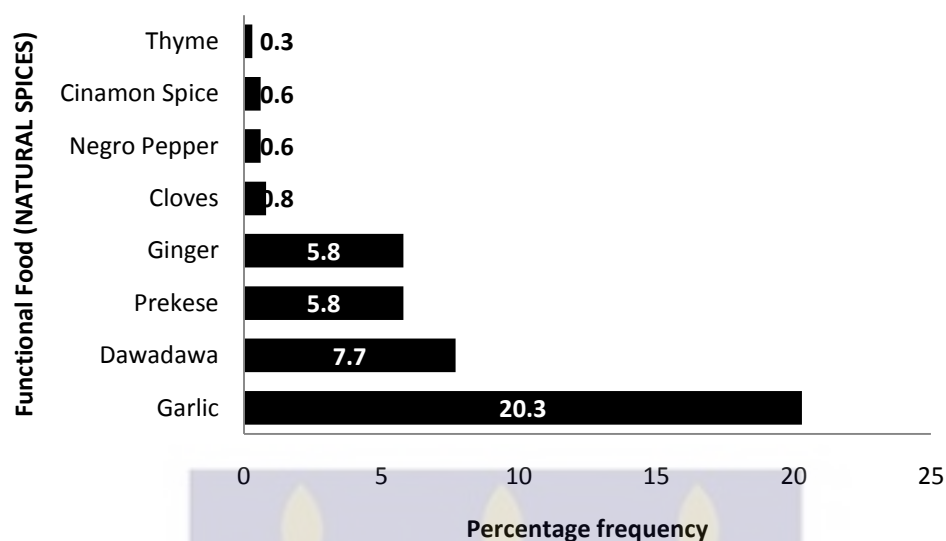


Figure 4. 11: Natural spice Perceived as FFD

4.2.9.8 Cereals, Legumes, Nut and Seed Perceived to have Nutraceutical Properties

Cowpea was most perceived FFD by respondents among this food group (11.9%). Most cereals, legumes, nuts and seeds have been associated with functional foods due to the unique bioactive compounds found in them. Cereals grains have as part of the major phytochemicals present in them to include phenolic acids, flavones, phytic acid, flavanoids, coumarins, and terpenes Jiwan *et al.* (2007). Cereal germs are good sources of vitamins (Vitamin E, B1, B2, and B3), minerals (P, K, Mg, Ca, Zn, and S), and fiber thus confirming their functional properties as a FFD. Dry beans (*Phaseolus vulgaris L.*) or cowpea is high in protein, fiber, prebiotics, vitamin B, and others. Alternatively, cowpea has also been linked to reduced disease risks, such as oxidative stress, inflammation, cancer, heart disease, and metabolic syndrome. Cowpeas are also composed of several types of prebiotics, including resistant starch (RS) and the fructo-oligosaccharides, stachyose and raffinose that serve as substrates for bacterial fermentation in the human intestine, thereby influencing the microbial ecology of the gastrointestinal tract (GIT) and gut metabolism. Peanuts and other tree nuts have been proven to be low in saturated fatty

acids and high in monounsaturated and polyunsaturated fatty acids. There are other bioactive compounds in peanuts and nuts that elicit positive healthful effects which have been identified as plant proteins, dietary fiber, micronutrients, plant sterols, and phytochemicals (Kris-Etherton *et al.*, 1999). These foods group could be said to play a lot of physiological functions in the body and thus was not surprising that consumers associate them with improved digestive problems, weight management, reduced cancers and general wellbeing.

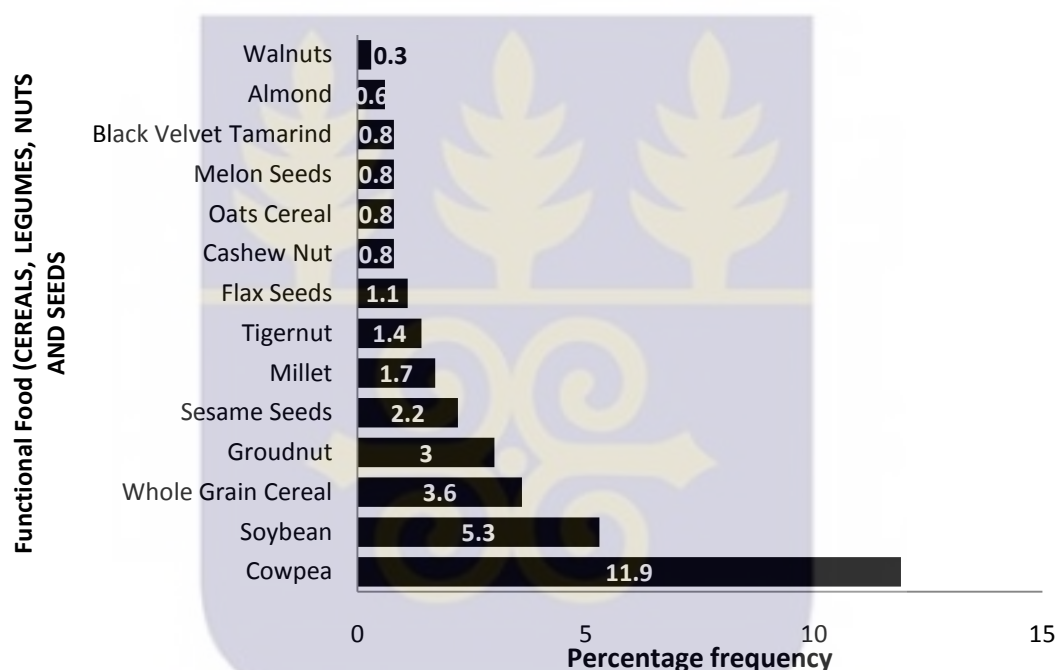


Figure 4.12: Cereals, Legumes, nut and seed perceived as FFD

4.2.9.8 Sea Foods and Dairy Products Perceived to have Nutraceutical Properties

Fish, oyster and yoghurt were the only foods within this category perceived to have nutraceutical properties. Fish and other sea foods were the most perceived FFD by respondents (1.9%) (Figure 4.13). Pre and probiotics usually found in most fermented dairy product have also been found to decrease the risk of some diseases. Fish and other sea foods are also rich in protein, vitamins, minerals and essential oils which impart positively on one's health. The American Heart Association (AHA) recommends that eating fish at least

two times per week as part of a healthy diet as it lower blood pressure and help reduce the risk of a heart attack or stroke.

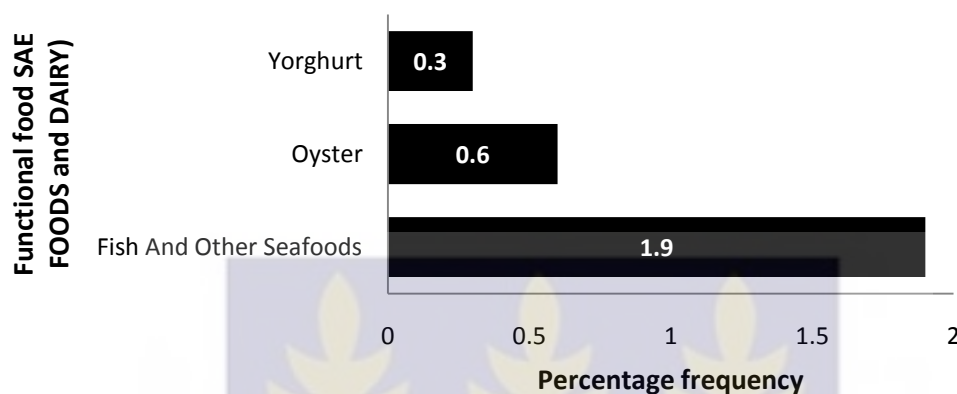


Figure 4.13: Sea foods and Diary and perceived as FFD

4.2.9.9 Other food commodities Perceived to have Nutraceutical Properties

Two and a halve percent (2.5%) of respondents perceived palm oil to have nutraceutical properties. The other food groups included palm oil, cocoa powder, honey, clinical/activated charcoal, mushroom and marijuana leaves among other foods (Figure 4.14). Palm oils is associated with good vision through the provision of vitamins A. Both leaves and seeds of Marijuana have also been found to affect human physiology including appetite, blood pressure, reproduction, bone growth, tumour modulation, immunity inflammation, pain sensation, memory, and muscle tone (Amentana, 2013). Cocoa powder and products has been associated with having antioxidant activities and aphrodisiac properties.

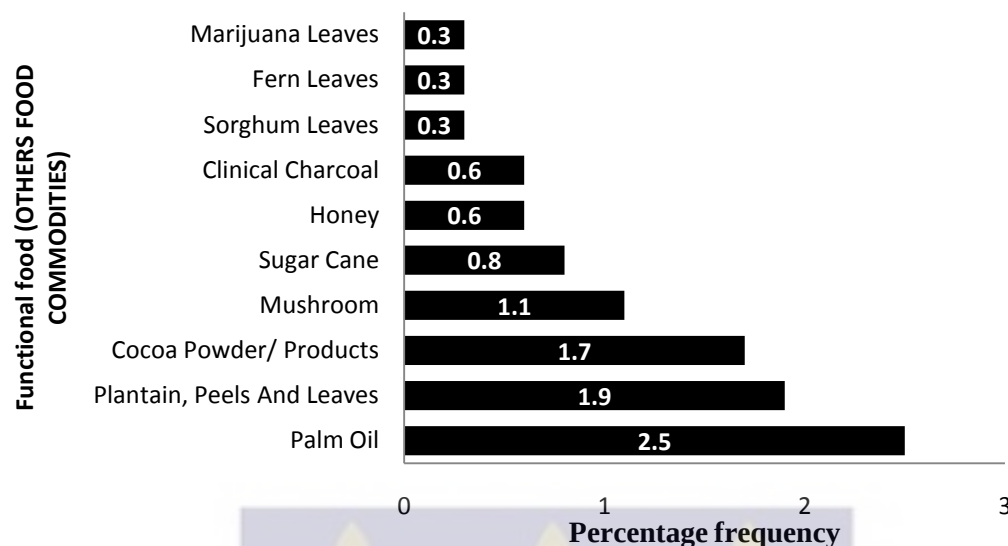


Figure: 4.14: Other Food commodities perceived as FFD.

It could be concluded that most respondents associate FFDs as being mostly natural foods other than health-promoting processed or fortified foods and products. However, Roberfroid (2000a); and Teck-Chai *et al.*, (2013), reported that FFDs includes fortified products; a food fortified with additional nutrients (fruit juices fortified with Vitamin C), enriched products; a food with added new nutrients or components not normally found in a particular food (margarine with plant sterol ester, probiotics, prebiotics), altered products; a food from which a deleterious component has been removed, reduced or replaced with another substance with beneficial effects (fibers as fat releasers in meat or ice cream products), non-altered products; foods naturally containing increased content of nutrients or components of natural foods, enhanced products; a food which one of the component has been naturally enhanced through special growing conditions, new feed composition, genetic manipulation or otherwise (eggs with increased omega-3 content achieved by altered chicken feed). Thus any food or product in any of the above category could be said to be functional. There is therefore the need for increased knowledge on FFD for consumers to be able to benefit from all the other FFD categories for their health benefits.

4.2.9.10: The top ten (10) FFD and the perceived health benefits by consumers

The top ten (10) FFDs were perceived by respondents to play medicinal roles of various kinds ranging from simple to more complex chronic and genetic disease conditions. Most of the foods were perceived to reduce the risk of chronic diseases and for general wellbeing, as well as play beneficial roles in relation to health, reproduction, digestion, immune and genetics, among others (Table 4.16). From the study, it could be seen that consumers have various perceived benefits associated with every FFD and could be a possible reason for its usage. As Jeżewska-Zychowicz, (2009) revealed in a study among young consumers, their willingness to use functional foods was strongly influenced by the expected or the perceived health benefit of the food, the need for the functional food, the confidence in the functional food and their safety.



Table 4.16 Perceived health benefits of the top ten (10) FFDs by Consumers

Food commodity		Perceived Health Benefits
1.	Leafy Vegetables	General wellbeing and boost body immune, gives blood to the body and prevent anemia, gives free bowels, gives vitamins, minerals and iron to the body, reduces blood cholesterol, help in weight management and gives fibre the body.
2.	Dandelion (<i>Taraxacum officinale</i>)	Help in blood circulation, boost the body immune, and improves general wellbeing, prevent and reduce high blood pressure and diabetes, clean the blood system, burns fat in the body, help manage asthma, good for the heart and proper cardiac functioning, help proper function of kidney and liver, help in weight management, help treat stroke, prevent menstrual pain.
3.	Orange (<i>Citrus sinensis</i>)	Aid in digestion and prevent constipation, boost the body immune and improve on health, treat stomach upset, gives vitamins (C) to the body, aid in wound healing, prevent bleeding gum and sores, treat common cold and blisters, reduce the risk of diseases.
4.	Moringa (<i>Moringa oleifera</i>)	Boost the body immune and prevent chronic disease, detoxify the blood system, cures a lot of diseases , fight against high blood pressure, for general wellbeing, help to manage stroke and diabetes, treat malaria fever and typhoid,
5.	Water Melon (<i>Citrullus lanatus var. lanatus</i>)	Help with prostate cancer, act as diuretic and clean the blood system, boost the body immune, the seed reduce high blood pressure and cholesterol, good for the management of diabetes and high blood pressure, treat inflammations of the stomach, for general wellbeing
6.	Banana (<i>Musa spp</i>)	Boost the body immune and for general wellbeing, contribute to healthy skin, reduces high blood pressure and good for the heart, help in the formation of blood, aid in sexual performance and erection in men, provide vitamins to the body and aid digestion.
7.	Pawpaw (<i>Asimina triloba</i>)	For general wellbeing, aid in digestion and gives free bowels, the seed act as de-wormer, protect against diseases.
8.	Carrot (<i>Daucus carota spp</i>)	Boost the body immune and for general wellbeing, good for the eye and skin, help to manage diabetes and high blood pressure, provide vitamins, help maintain healthy weight and reduces cholesterol.
9.	Cabbage (<i>Brassica oleracea</i>)	Boost the body immune and for general wellbeing, improves health, help to manage high blood pressure, prevent stroke.
10.	Garlic (<i>Allium sativum</i>)	Act as antioxidant, good for the heart and eyes, purify the blood system, burns and reduce fat and cholesterol in the body, boost the body immune, help in proper heart functioning and blood flow in the body, reduces high blood pressure, help in proper kidney function, prevent cancers, remove phlegm from the body, treat convulsion in children, treat and manage asthma.

4. 3 Chemical analysis of bioactive Compounds in Selected FFDs

4.3.1 Total Polyphenols, Carotenoids, Tannins and Ascorbic Acid Content of Selected FFDs

Total polyphenols varied for all FFDs analyzed. High levels of polyphenols were observed for basil (86.15mgGAE/g) followed by black velvet tamarind (80.64mgGAE/g) and was least for *Tetrapleura tetraptera*, (30.16mgGAE/g). Total carotenoids ranged from (32.21-0.302) mg/100g of the samples analysed. Watermelon recorded the highest ascorbic acid content (83.78mg/100ml), while black velvet tamarind had the lowest ascorbic acid (17.27mg/100ml). Total tannins content was highest in kontomire (*Xanthosoma plant*) and lowest in watermelon (0.137 and 0.0091) mgTAE/g respectively (Table 17). There were significant differences among all the samples for their total polyphenols, total carotenoids, ascorbic acid and total tannins ($p < 0.05$) (Appendix 5).

Table 4.17 Mean levels of Bioactive Compounds for Selected FFDs

SAMPLE	TOTAL POLYPHENOLS (mg GAE/g)	TOTAL CAROTENOIDS (mg/100g)	ASCORBIC ACID CONTENT (mg/100ml)	TOTAL TANNINS (mg TAE/g)
<i>(xanthosoma plant)</i> (Kontomire)	41.54±1.83 ^d	32.21±0.38 ^e	68.99±8.54 ^d	0.137±0.005 ^a
Prekese (<i>Tetrapleura tetraptera</i>)	30.16±0.21 ^e	1.30±0.04 ^a ^b	24.64±4.27 ^{ab}	0.023±0.002 ^d
Black velvet tamarind	80.64± 1.61 ^b	0.302±0.007 ^a	17.27±4.27 ^a	0.0560± 0.0003 ^c
Watermelon	73.92± 4.44 ^c	4.90±0.82 ^c	83.78±8.54 ^e	0.0091±0.0008 ^e
Basil (<i>Ocimum basilicum</i>)	86.15± 2.22 ^a	22.21± 0.65 ^d	44.35±7.39 ^c	0.087±0.003 ^b

GAE: Gallic Acid equivalent, TAE: Tannic Acid Equivalent

P-values with different superscript within the same column are significantly different ($p < 0.05$)

4.3.2 Antioxidant activity of selected FFDs

Percent antioxidant activity increased with increasing concentration of the samples. Butylated hydroxyl toluene (BHT) was used as a reference standard. At low concentrations of 5mg/ml; watermelon recorded high antioxidant activity and the least for black velvet tamarind. At high concentration BHT recorded the highest antioxidant activity followed by kontomire, watermelon, *Tetrapleura tetraptera* (prekese), basil and black velvet tamarind. The antioxidant activity of all the samples correlated well with the standard antioxidant.

Table 4.17 Antioxidant activity (%) of selected FFDs

CONCENTRATION (mg/ml)	Antioxidant Activity (%)					
	BHT	KONTOMIRE	BASIL	WATER MELON	BLACK VELVET TAMARIND	PREKESE
20	93.33	76.15	62.98	74.59	54.17	66.91
15	42.13	32.56	29.21	73.98	36.40	65.47
10	25.14	29.03	28.66	64.54	24.46	57.41
5	24.11	28.75	25.45	48.28	23.48	39.31

The presence of bioactive or functional components and chemicals in foods such as carotenoids, phenolic compounds, essential minerals, lipids, proteins has drawn attention to the benefits of FFD over the last decades (Scalzoa *et al.*, 2005). These compounds usually referred to as phytochemicals are secondary metabolites which play diverse biological and physiological roles in the body enhance reducing the risk of aging,

cardiovascular disease, cancer, inflammatory disease, skin disease, malaria, immune deficiency disease and other age-related degenerative diseases.

The leaves of *Xanthosoma plant* commonly called “kontomire” are among the numerous wild vegetables used traditionally in meal preparation especially in many tropical countries (Lumu, 2011) including Ghana. “Kontomire”, a leafy vegetable was perceived to be among the top ten FFD by consumers. “Kontomire” recorded high carotenoid and polyphenol content (32.21 mg/100g and 0.137 mg TAE/g) respectively (Table 4.16). Reports reveal that it is rich in protein, amino acids, vitamins and minerals (Leterme *et al.*, 2005; Mbofung *et al.*, 2006). Although carotenoids are present in many common foods, deeply pigmented fruits, juices and vegetables constitute the major dietary sources and dark green vegetables providing lutein (Rao and Rao, 2007). The high carotenoid content recorded for kontomire could be attributed to the deep pigment associated with it.

Carotenoids positively impact on health by acting as antioxidant and in other physiological activities. The carotenoid composition of foods are known to be affected by factors such as cultivar or variety; part of the plant consumed; stage of maturity; climate or geographic site of production; harvesting and postharvest handling; processing and storage (Rodriguez-Amaya and Kimura, 2004). Tannins are a group of long polymers of polyphenolic compounds which have the ability to reduce digestibility of dietary protein by forming insoluble complexes with both dietary protein and digestive enzymes (Biagi *et al.*, 2010). Therefore intake of large quantities of foods high in tannins leads to reduced availability of certain essential nutrients particularly proteins, minerals and vitamins (Savage *et al.*, 2000). However, despite these anti-nutritional properties, tannins play beneficial roles such as antibacterial and anti-diarrheic, thus of interest in phytochemical analysis. Tannins act as metal ion chelators and antioxidants making it beneficial to health as well (Biagi *et al.*, 2010). Therefore “kontomire” may serve the perceived health benefits

as a FFD, the amount taken in and the rate of consumption should be considered. Processing methods including cooking, drying and soaking may however aid in reducing the adverse effect of these compounds in such foods.

Tetrapleura tetraptera “prekese” recorded lowest level of polyphenol among the foods analysed (30.16mgGAE/g) and performed poorly for its total carotenoid content (1.30mg/100g) (Table 4.16). Ascorbic acid content recorded was quite good for *tetrapleura tetraptera* compared to the levels obtained for black velvet tamarind. *Tetrapleura tetraptera* are among the foods perceived to have nutritional and medicinal value (Adetunji and Aladesanmi, 2006). The fruits are used for the treatment of several ailments including arthritis, asthma, diabetes mellitus, hypertension, epilepsy, schistosomiasis, and even prevention of post-partum contraction and gastro-intestinal disorders (Badu *et al.*, 2012) in foods and as teas. The potency of *Tetrapleura tetraptera* as a FFD may be less as it is used in minute quantities usually for its flavour and aroma other than its health benefits. Consequently the health beneficial phytochemicals may not be a good source as they occur in low concentration.

Black velvet tamarind is a seasonal wild plant found in mostly in Thailand and in some part of Africa and a cheap source of some health promoting phytochemicals (Ofosu *et al.*, 2013). Compared to the other foods analysed, black velvet tamarind was low in total carotenoid content (0.302mg/100g) and ascorbic acid (17.27mg/100ml) but recorded the 2nd highest for its total polyphenols content (80.64mgGAE/g) quite high (Table 4.16). Thus fruits of black velvet tamarind may be a very excellent source of polyphenols to the body but not for its carotenoid and ascorbic acid. Ascorbic acid is easily degradable by light, pH, temperature (heat), oxygen exposure, the presence of oxidizing metals or enzymes (Phillips *et al.*, 2010) and could have accounted for the low ascorbic acid of the black velvet tamarind fruits. These are dried fruits exposed to light, oxygen and high

temperatures and might have accounted for the low level of the ascorbic acid in the black velvet tamarind fruits.

Watermelon recorded highest ascorbic acid among the foods analysed (83.78 mg/100ml) (Table 4.16). Polyphenols level was quite high (73.92mgTAE/g). Total carotenoids content was quite low. Watermelon can be recommended as a good dietary source of ascorbic acid to the body as it is eaten fresh and uncooked reducing the extent of ascorbic acid degradation by heat and oxygen. The fruit may also be eaten to provide other health promoting phytochemicals to the body.

Basil recorded the highest polyphenol content (86.15mgGAE/g) and 2nd highest in carotenoids content (Table 4.16). Basil leaves are among the common aromatic herb used to add and flavour to foods (Lee *et al.*, 2005). Basil has been found to be high in polyphenol, carotenoids and a good antioxidant activity and numerous studies have shown that volatile oils have antibacterial, antifungal, antiviral, insecticide and antioxidant properties (Ismail, 2006). It is therefore not surprising that the leaves of basil are used in folk medicine to treat several ailments (Baytop, 1984). Basil may positively affect the health of consumers by executing high antioxidant activity especially due to the polyphenols present in high concentrations. However, its actual usage is sometime limited to a few leaves to impart flavour and aroma other than the levels needed to achieve the supposed health benefit.

All selected FFDs analysed had antioxidant activities and could be a potential source of antioxidant to the body. Kontomire recorded activity of (76.15%) followed by watermelon (74.59%) at high concentrations thus comparing well with the standard antioxidant used (BHT). Activity at lower concentration is associated with the potency of the food to scavenge free radicals at lower level of compounds with antioxidant activity. Watermelon at lower concentration recorded an activity of 48.28%, signifying that even at low

concentration watermelon could potentially reduce free radical up to about 50%. The antioxidant activity in foods is associated with the presence of mainly phenolic compounds; phenolic acid, flavanoid, tannins (etc) and vitamins (carotenoids, ascorbic acid, vitamin E etc) and it is established that the function of reactive species is highly related to their concentration (Badu *et al.*, 2012). Antioxidant is a molecule capable of slowing or preventing the oxidation of other molecules. Antioxidants terminate these oxidative reactions chain that damage cells by removing free radical intermediates, and inhibit other oxidation reactions by being oxidized themselves (Halliwell, 1990; Genestra, 2007). Accumulation of free radicals in the body may cause several conditions including the development of atherosclerosis, cancer, and cataract and destruction of B-cells and impairment of insulin action leading to diabetes (Francisco and Resurreccion, 2008). The efficiency of polyphenols as antioxidant compound is greatly dependant on their chemical structure while the antioxidant properties of carotenoids have also been suggested to be the main mechanism by which they afford their beneficial effects. It should be noted that antioxidant activity is highly dependent on the amount of the foods consumed as well as the concentration of these reactive species present in them.

Functional foods could be said to contain significant levels of bioactive compounds in them. Adequate intake of FFDs by consumers may help reduce the risk of some disease conditions and improve health and general being.

CHAPTER 5

5:0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

- There is a high level of awareness among consumers and a fair knowledge about FFDs and the roles they play in human health and general well being. While awareness was not significantly different between urban and non-urban respondents; the knowledge, beliefs and perception, sources of information, as well as the etiology of life style disease condition were significantly different. The peri-urban respondents need to be educated more on FFDs for them to benefit from the positive effect of FFDs on their health.
- The media especially the electronic media constituted the most frequent information source on FFDs. However other sources of information were family and friends, hospital, internet and other club associations. The main concern is authenticity of the source of information, and whether it is based on scientific evidence.
- Hypertension and stroke continue to be the two most prevalent diseases among most respondents and their household/ family members. Healthy dietary strategies need to be encouraged to minimize the prevalence of the disease conditions.
- The perceived health benefits of foods continue to drive the willingness of consumers to use FFD; however there exist some fears and challenges.
- Different food commodities are perceived to be functional, however fruits and vegetables were the most perceived FFDs. Price and seasonality continue to affect

their usage. There should be more consumer education to expose them to the numerous positive health benefits found in other FFDs.

- Among the foods perceived to have nutraceutical properties there are some levels of bioactive compounds in them but in varying concentrations for the different foods analyzed.

5.2 Limitations of the study

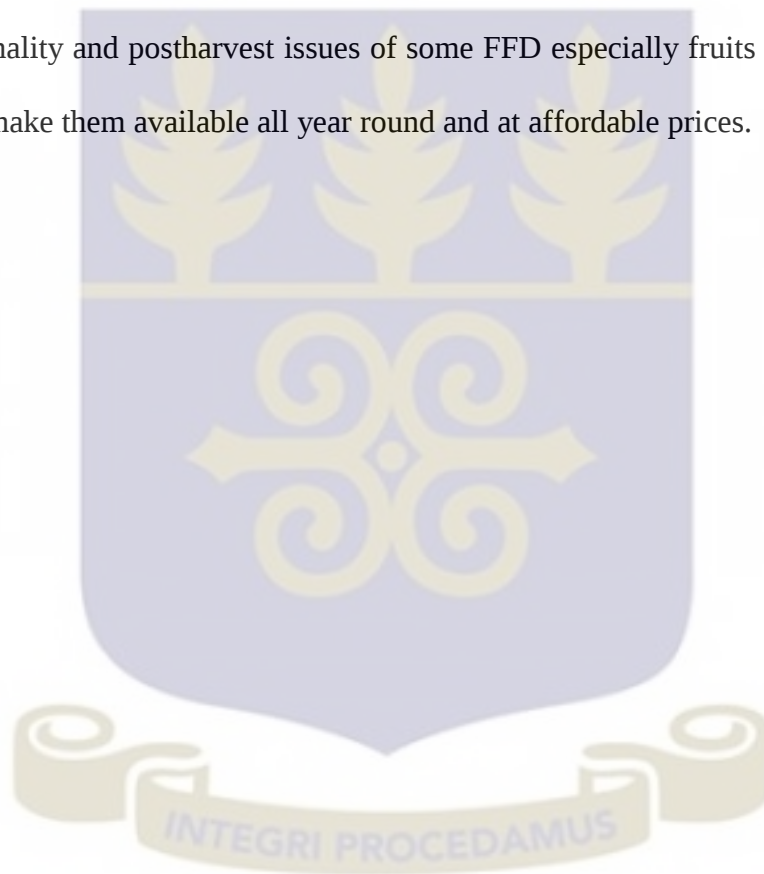
- The possible influence of respondents by other consumers at the time of interview as most interviews were conducted among groups even though was at individual levels.
- The non-urban location made use of consumers at the household level unlike the urban location where different locations were purposively sampled (hospital, church and institution). This could have made a better comparison.

5.3 Recommendation

It is recommended that,

- Further studies should be carried out at different regions with increased sample size to be able to document other FFDs across the country and also to explore the influence of ethnicity and culture on the knowledge, perception and usage FFDs.
- Consumer advocacy groups should be informed through the study outcome to ensure that, right information is given to the public concerning FFDs in general by the right persons. This will also help in providing scientifically based education to consumers to clarify some myths and fears surrounding foods especially FFDs in general.

- Detailed nutraceutical studies should be carried out on the functional food commodities to determine their potency in alleviating certain chronic diseases such as their anti- hypertension and anti- cancer properties.
- Consumers should be educated to consume more FFDs and in the recommended amount to attain the health benefits associated with these foods to help prevent and control certain diseases and improve their health and wellbeing.
- The study could be adapted to aid in policy formulations for addressing the seasonality and postharvest issues of some FFD especially fruits and vegetables to help make them available all year round and at affordable prices.



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APPENDICES

APPENDIX 1: INFORMED CONSENT FORM

UNIVERSITY OF GHANA

DEPARTMENT OF NUTRITION AND FOOD SCIENCE KNOWLEDGE, PERCEPTION and USAGE OF FUNCTIONAL FOODS AMONG GHANAIS: A CASE STUDY IN THE GREATER ACCRA REGION.

INFORMED CONSENT FORM

**Title: Knowledge, Perception and Usage of Functional Foods among
Ghanais: A Case Study in the Greater Accra Region**

Principal Investigator: Asantewaa Afia Wiafe

**Address: Department of Nutrition and Food Science, University of Ghana, Legon,
Accra.**

General Information about Research

The study mainly seeks to assess consumers' perception, knowledge and usage of **functional foods** (foods with special medicinal/ health benefit to the body). This research is solely for academic purposes. "Foods that may provide health benefits beyond basic nutrition" and "Food similar in appearance to conventional food, that is intended to be consumed as part of a normal diet, but has been modified to sub-serve physiological roles beyond the provision of simple nutrient requirements" are termed "functional". Functional foods provide the necessary nutrients for humans but also prevent nutrition-related diseases and improve physical and mental well-being of the consumers. The objective of the research is to assess **Knowledge, Perception and Usage of Functional Foods among Ghanais: A Case Study in the Greater Accra Region.**

If you agree to be in this study, we will conduct an interview with you. During the interview, we will ask questions about a few background information, your knowledge, perception, sources of information, challenges and the extent of usage of foods with

medicinal/ health benefits (functional foods). The interview will take about 15 minutes to complete.

Benefits/Risk of the study

There is no direct benefit to you for participating in the study. However, it is anticipated that the results from the study will benefit consumers in general and inform our choice of foods with medicinal benefit that its usage is rapidly on the increase in the country. There are no risks involved in participating in this study (non invasive/ emotional).

Confidentiality

The records of this study will be kept private. In any sort of report we make public through publication, we will not include any information that will make it possible to identify you. We will protect information about you to the best of our ability. You will not be named in any reports.

Compensation

You participating in this study will not incur any cost and completely voluntary. At the end of the interview, you will be given a thank you gift (napkin/ face towel) to compensate you for your time and effort for participating in the study.

Withdrawal from Study

Taking part in this study is completely voluntary. You may skip any questions that you do not want to answer. If you decide to take part, you are free to withdraw at any time without penalty. If there are any reasons to necessitate your continuation or withdrawal from the study, you or your legal representative would be timely and adequately informed.

Contact for Additional Information

If you have questions or require additional information regarding this study, you may contact Asantewaa Afia Wiafe at asantebei@gmail.com or on the number **0249148188** or Prof Agnes Budu on the number **0244273577** all of University of Ghana, Legon.

Volunteer's agreement form

"I have read or have had the purpose of the study explained to me regarding participation in this study, and am willing to give consent to participate in this study. I will not have foregone any of my rights by signing this consent form. Upon signing this consent form, I willingly agree to be part of this study."

Name of Volunteer

Signature or mark of volunteer Date

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

Name of witness

Signature of witness Date.....

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

Name of Person who Obtained Consent

Signature of Person Who Obtained Consent Date

APPENDIX 2: CONSUMER SURVEY QUESTIONNAIRE

DEPARTMENT OF NUTRITION AND FOOD SCIENCE, UNIVERSITY OF GHANA

Questionnaire No.....

Interviewer.....

Date:.....

PREAMBLE

This **consumer survey** seeks to assess your opinions, awareness, and usage of **functional foods** in Ghana.

NOTE: Functional foods are defined as “**Foods or food commodities eaten that may provide special medicinal or health benefits to the body beyond basic nutrition**”. We are interested in your opinions about **functional foods**. We would be grateful if you would take a little time out of your busy schedule to complete this questionnaire. There is no right or wrong answers. We are interested in learning from you, your opinions and awareness about the topic. **You may circle, tick or write the appropriate response in the box.**

(A) Socio-demographic Data / consumer background information.

1. Which age group are you (years) ?

18-29= 1 30-39= 2 40- 49= 3 50-59= 4 60-65= 5 65-75 =6 >75

☐

2. Gender (please tick appropriately).

M

☐

F

☐3. What is your **tribe/ ethnic group**?Ewe= 1 Ga/Adangbe = 2 Northern ethnicity (eg Dagomba, Frafra, Gonja etc) = 3
Akan (Fante, Ashanti, Akuapem etc) = 4 Foreigner = 5☐4. What is your **marital status**?

Single =1 Married= 2 Widowed= 3 Divorced= 4

☐

5. What is your highest level of education?

None= 0 primary= 1 JHS= 2 Vocational =3 Secondary=“A”& “O” level =4 Tertiary= 5
Post Graduate= 6.☐6. What is your **Profession/ Occupation**?Not working=1 Salary worker= 2 vocational worker (mechanics, hairdresser etc)=3 Trader= 4
Business owner (shop, enterprise, company etc) =5 others.....☐

7. What is your religion?

Christianity =1 Moslem= 2 Traditionalist= 3 others= 3.....

☐

8. How much do you earn on the average in a month?

<50=1 50-<100=2 100-<300=3 300-<500=4 500-<1000=5 1000-<1500=6 ≥ 1500 =6

☐

9. Where do you reside currently? (Please specify)

(B) Knowledge, Beliefs and attitude towards Functional Foods

10. Have **you heard** that some foods have **special health benefits** to the body? YES
NO
(Circle appropriately)

11. Can you please **list the types** of these foods that you know?

.....
.....

12. Do you know about **some the medicinal properties or components in the foods** that provide the health or medicinal benefits?

YES NO

12b. If yes, please mention some of them

.....
.....

13. Do you think only those who are **unhealthy (ill)** should use these foods with health or medicinal benefits to the body? YES NO

13b. Give reason for your choice.....

.....
.....

14. What are some of your personal **beliefs and perceptions** about foods and some of the foods you have heard to have health or medicinal properties? (Give as many as possible)

NOTE:

- **Beliefs and perceptions are mentally accepted claims (culture, taboos) or consciously understanding and being aware of something as the truth with or without supportive facts (may not be necessarily true).**

.....
.....
.....
.....
.....

15. Do any of the **beliefs and perceptions** affect your choice of foods?

Never=1 Rarely = 2 Sometimes=3 Often=4 Very often= 5

16. For the foods that you have heard have health or medicinal benefits, **how did you hear** about it? (Choose all that apply)

INFORMATION SOURCE	YES/ NO	Your level of trust in the source Strongly=1 Moderately=2 Don't trust =3
Family/ Friends		
Hospital		
Media		
Books and magazines		
Internet		
Hear say		
Others		

17. Do you or any member of your household have the disease conditions/ disorder listed below? **(Choose all that apply)**

Condition	You (YES/ NO)	Household/Family member (YES/NO)	Any strategy/ special diet or Food commodity to manage or treat the condition
Diabetes			
Hypertension			
Stroke			
Cancers			
Others			

18. Have you seen an **improvement in the condition** or **positive results**?

YES / NO

18b. Give reason.....
.....

19. Do you have any **fears concerning** the use of these foods with health or medicinal benefits?
YES / NO

19b. If yes what are some of the **fears / concerns**?

.....
.....

(D) Foods Perceived as Functional foods and Extent of Usage

Please, can you now list the foods with special medicinal or health benefits to the body that you have **used before or aware of** : (drink, cereal, legume, nuts, natural spice, herb, spread, fruit and vegetables etc). Please give as many as possible.

Food Commodities with medicinal or health benefits	Common name in the society	About how long have you heard about the food; (Very long= >10 yrs, Moderately long= > 5yrs, Quite recently= 2- 5yrs)	How often do you averagely use this FFD (occasionally, everyday, once, twice, thrice or more)	Perceived medicinal or health benefits

(C) Determinants and impeters to the use of functional foods

20. For the list below choose **the factors that influence your choice** of foods with medicinal or health

Factor	YES/ NO
Health benefit	
Sensory (taste, appearance etc)	
Price	
Convenience	
Others (specify)	

21. Would you be **willing to try** other functional foods if you are convinced about the medicinal or health benefits? YES / NO

21b. Give reason for your choice.....
.....

22. Would you be willing to **pay extra money** for a food with special health or medicinal benefits compared to one which is not? YES / NO

23. What are some of the **challenges or problems** you experience with using these foods with medicinal or health benefits?.....
.....

24. Do you take in any **nutrient supplements**? YES / NO

25. If yes, **please specify**.

26. Why do you take the supplement?.....
.....

THANK YOU FOR YOUR TIME



APPENDIX 3: PRACTICES AND COMMENTS OF SOME CONSUMERS ON THE USE OF FFDS

Practices and comments of consumers on the use of FFDS

“I blend Solanum torvum and add to a glass of milk to give my child blood whenever he is diagnosed to be anemic by the doctor”

“I only became conscious of my diet and for that matter some of these functional foods when I had a mild stroke about a month ago. Now I can walk. My friend introduced me to dandelion”

“In our part of the region; the northern region we don’t have “kontomire” (cocoyam leaves) so we use cassava and beans leaves in meal preparation”

“I cook the marijuana leaves with other green vegetables when preparing my stew. I don’t smoke it now but rather I eat the fresh leaves”

“Sometimes the media especially give counter education on the benefits of some of the foods, the time to eat them and the right amount to take at a time”.

“Most processed foods are not healthy as well as the synthetic spices (maggi, royco and onga cube brands); they lead to stroke, hypertension and diabetes”

“There should be increased consumer education on which foods are healthy and good for our health”



APPENDIX 4: SAMPLE CALCULATION FOR LABOLATORY ANALYSIS USING COCOYAM LEAVES (KONTOMIRE).

i. Ascorbic acid content

Mg ascorbic acid per 100ml extract= dye equivalent* titre* dilution (200).

Where dye equivalent is obtained from the titration of the standard dye prepared.

If dye equivalent is 0.3696 and titre value for cocoyam leave is 0.8 then;

Mg ascorbic acid per 100ml extract= $0.3696 \times 0.8 \times 200$

59.136mg ascorbic acid wet matter basis

ii. Total carotenoid determination

Total carotenoid content ($\mu\text{g/g}$) =

$$\frac{\text{Absorbance} \times \text{total volume of extract (ml)} \times 10^4}{\text{Sample weight (g)} \times \text{absorption coefficient of B-carotene (2592)}}$$

If absorbance of cocoyam leaves (test sample – blank) is 0.349, total volume of extract is 25ml and sample weight is 0.1038g, then;

$$\text{Total carotenoids content} = \frac{0.349 \times 25\text{ml} \times 10^4}{0.1038 \times 2592}$$

324.29 $\mu\text{g/g}$ wet matter basis

iii. **DPPH scavenging effect Q(% reduction of DPPH)**

$$Q(\%) = \left(1 - \frac{A_0}{A_c}\right) * 100 \quad \text{If } A_0 \text{ is } 0.091 \text{ and } A_c \text{ is } 0.1195, \text{ then;}$$

$$Q(\%) = 1 - \left(\frac{0.091}{0.1195}\right) * 100$$

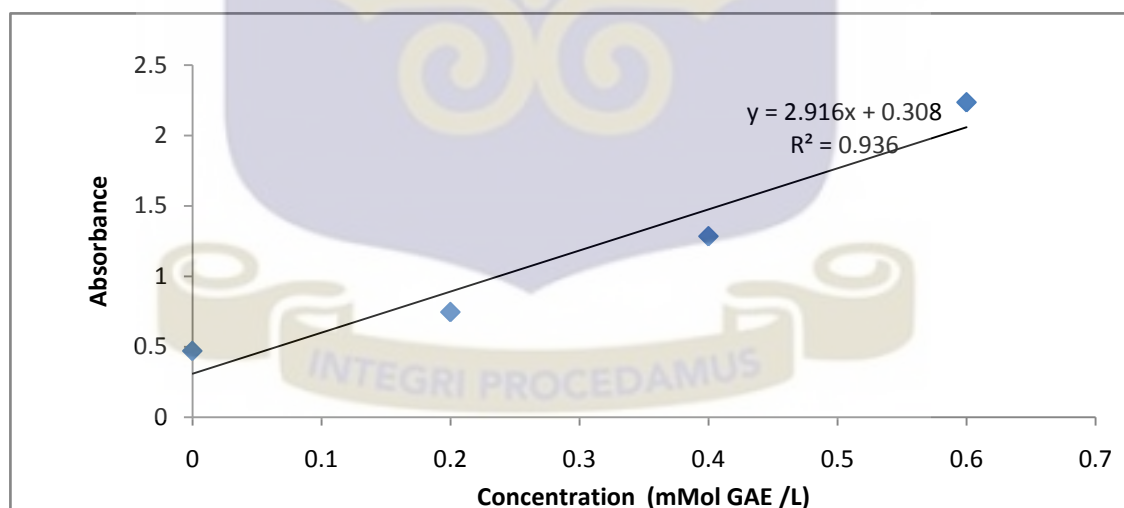
23%

% Antioxidant activity: 100-(%Q)

(100-23)%

77% (20mg/ml concentration)

iv. **Total Polyphenols**



Standard curve for Gallic Acid

Total polyphenols=

$$\frac{\text{concentration}(\text{mMol} / \text{L}) * \text{DF} * \text{volume of extract}(\text{L}) * \text{Amount of test sample}(\text{L})}{\text{weight of sample}(\text{g})}$$

If sample concentration is 0.687, dilution factor(DF) 201, volume of extract 0.025L, amount of extract 1ml and weight of sample 0.5017g then;

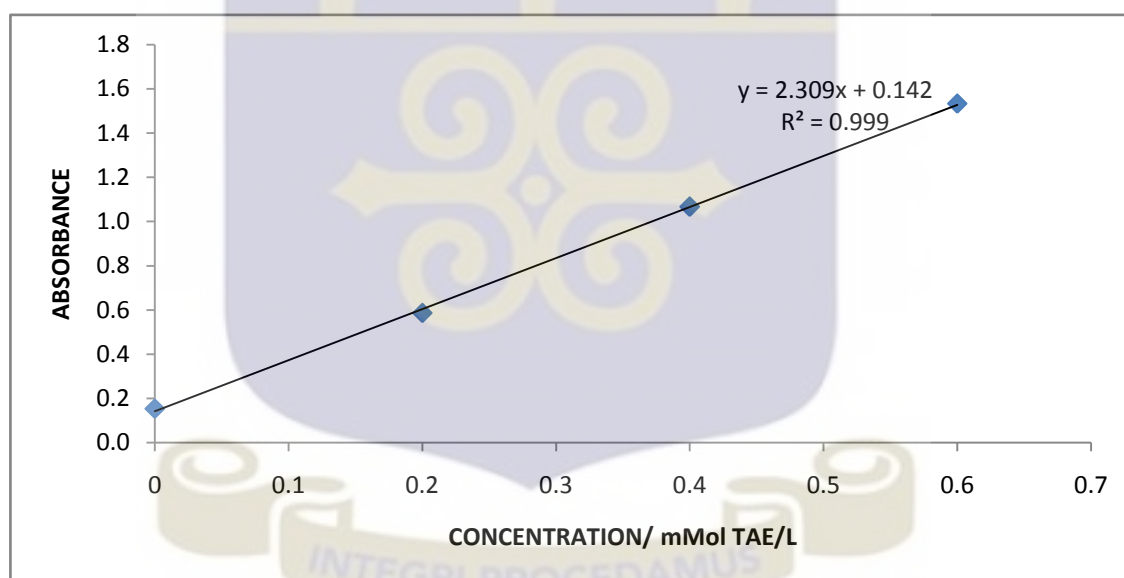
$$\text{Total polyphenol} = \frac{0.687 * 201 * 0.025L * 1ml}{0.5017 * 1000}$$

6890.56mlMolGAE/g of sample,

But Molar mass of Gallic acid is 170.12g/Mol

$$\frac{6890.566}{170.12} = 40.50 \text{ mgGAE/g of sample}$$

v. *Total Tannins determination*



Standard curve for Tannic Acid

Total tannins concentration =

$$\frac{\text{concentration}(mMol / L) * DF * \text{volume of extract}(L) * \text{Amount of test sample}(L)}{\text{weight of sample}(g)}$$

If sample concentration is 0.0450, dilution factor (DF) is 101, volume of extract 0.025L, amount of extract 1ml and weight of sample 0.5032g then;

$$\text{Total tannins} = \frac{0.0450 \times 101 \times 0.025L \times 1}{0.5032 \times 100}$$

226.01mg TAE/g of sample; but molar mass of Tannin acid is 1701.12g/Mol

$$\frac{226.01}{1701.12} = 0.132\text{mg TAE/g}$$



APPENDIX 5: ANOVA OUTPUT FOR LABORATORY ANALYSIS**One-way ANOVA: POLYPHENOLS (mgGAE/g) versus sample**

Source	DF	SS	MS	F	P
sample	4	7512.91	1878.23	306.88	<0.001
Error	10	61.2	6.12		
Total	14	7574.12			

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	
1	3	41.539	1.831	(--*)
2	3	30.158	0.210	(--*)
3	3	80.642	1.611	(--*)
4	3	73.929	4.437	(--*)
5	3	86.147	2.218	(--*)

32 48 64 80

One-way ANOVA: TOTAL CAROTENOIDS (mg/100g) versus sample

Source	DF	SS	MS	F	P
sample	4	2442.633	610.658	2458.46	<0.001
Error	10	2.484	0.248		
Total	14	2445.117			

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	
1	3	32.212	0.376	(*)
2	3	1.301	0.036	(*)
3	3	0.302	0.007	(*)
4	3	4.904	0.822	(*)
5	3	22.208	0.650	(*)

0 10 20 30

One-way ANOVA: ASCORBIC ACID CONTENT (mg/100ml versus sample

Source	DF	SS	MS	F	P
Sample	4	9675.2	2418.8	51.08	<0.001
Error	10	473.6	47.4		
Total	14	10148.8			

Source	DF	SS	MS	F	P
sample	4	0.0322432	0.0080608	1295.39	<0.001
Error	10	0.0000622	0.0000062		
Total	14	0.032054			