KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KNUST

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STUDIES ON THE USE OF TWO PACKAGES ON SOME CHEMICAL AND SENSORY PROPERTIES OF 'FRESH TASTE': A NATURAL ORANGE DRINK

MASTER OF SCIENCE IN FOOD SCIENCE AND TECHNOLOGY

BY

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BY

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DECLARATION

I hereby declare that this work, submitted to the School of Graduate Studies, KNUST, Kumasi, is the result of my own investigation towards the award of MSc. Food Science and Technology degree. This submission has not been presented for any degree elsewhere and that all references to other people's works have been duly cited.

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DEDICATION

For giving me the best of all they had and withholding nothing good from me;

I gladly dedicate this thesis report to my parents Mr. and Mrs. Mensah.

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My utmost thanks go to the Giver of all wisdom, the source of all understanding in literature and science

To my priceless parents Mr. and Mrs. Mensah, I say thank you for giving me all the best you have and may God always cause the lines to fall on you in pleasant places

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ABSTRACT

A comparative study on the effects of High Density Polyethylene bottle and High Density Polyethylene sachet on some quality attributes of a natural orange drink product (Fresh Taste) was conducted upon storage of samples of the products under refrigeration, room and outdoor conditions over a 7-week period. Microbial load (Yeast and Coliform), Total Titratable Acidity (TTA%) and Organoleptic perceptions of trained sensory panelists were used as the measurable indicators. No significant differences were observed between the effectiveness of the protection provided by the High Density Polyethylene bottle and the High Density Polyethylene sachet at 95% confidence level. The effect of the alternative package (labeled High Density Polyethylene bottle) on communicativeness or marketability (communication function) was also evaluated using 100 panelists. The alternative package was unanimously preferred by all the panelists. A significant difference was detected between the effectiveness of the communication function of the alternative package (labeled HDPE bottle) and the existing package (HDPE sachet) of Fresh Taste.

A survey was conducted to ascertain the veracity of the assertion that ‘the quality or standard of packaging of most food and beverage products made in Ghana is poor’ using structured questionnaires. The stakeholders interviewed namely consumers of food and beverage products, converters, users and some selected corporate respondents asserted that, the quality of packaging of most food and beverage products made in Ghana was not poor at 95% confidence limit.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Packaging is one of the most critical factors or components in the value-addition chain of activities in the food or agro-processing industry. A functional package is used to contain, protect, and preserve products throughout their distribution, storage and handling. It is also used to communicate to potential users in addition to providing convenience during usage (Robertson, 1993). Effective and efficient packaging of food and beverage products have been advocated as a means of developing new food products that impact positively on marketability and product quality (Mante, 2005). Developing such packaging requires multidisciplinary expertise ranging from graphic designers, food chemists, food technologists, nutritionists, home economists, food engineers, sales and marketing personnel, packaging design technologists, biochemists, microbiologists, legal experts and ICT professionals (Baker *et al.*, 1988). The cost involved and the spectrum of knowledge and expertise required probably explains why packaging is not widely researched and/or documented especially in Ghana where innovative packaging is not well appreciated by both consumers and food processors (Mante, 2005). Tetrapak packaging (liquid paperboard cartons), the first of its kind in the country was introduced into the Ghanaian market by Astek Ghana Limited for their fruit juice production. The portable and economically well-apportioned carton provided consumers with convenience, an unmet or inadequately satisfied functional need. It was relatively cheap and this resulted in its acceptability and sudden increase in sales (Kudzodzi, 1993).

Packaging provides added economic value to locally made food and beverage products desired by consumers. It is estimated that, about fifty percent (50%) of agro-processed products in the West African sub-region is wasted due to lack of an efficient and adequate packaging system (Boga-N'guessan, 2005). Foreign food and beverage products have secured shelf space on the Ghanaian local market with little difficulty mainly because of their more functional packaging designs (Mante, 2005). Currently in Ghana, consumer right awareness, appreciation of innovation in food packaging designs and access to technological advancements in domestic culinary appliances are on the increase. This is in tandem with increased influx and availability of newly developed food and beverage products on the local market premised on packaging (Oteng-Baafi, 2006). This awareness underscores the concerns expressed at various seminars and workshops that the standard or quality of packaging of most food and beverage products made-in-Ghana (MIG) is poor and underdeveloped (Mante, 2005).

1.2 Study Objective

The study sought to compare the effects of an alternative package on a natural orange drink product (Fresh Taste) with the existing package. This was premised on two of the key functions of a food and beverage package namely protection and communication. In addition, the study was initiated with the objective of appraising the opinions of stakeholders of the food and beverage (F&B) industry on the standard or quality of packaging of food and beverage products made in Ghana. The specific objectives are to:

- collate relevant information as a basis to substantiate or otherwise refute the assertion that 'the standard or quality of packaging of most food and beverage products made in Ghana (MIG) is poor'

- design an alternative package for Fresh Taste and test the relative effectiveness of its protective function through shelf life studies
- evaluate the relative effectiveness of the communication function of the alternative package design of Fresh Taste using a laboratory acceptance panel

1.3 Justification

Research and review work on food and beverage packaging in Ghana are very limited (Mante, 2005). Essuman, (2007) opined that, the packaging industry in Ghana is not well developed to meet the demands of global and national standards. At the industrial level where packaging contributes significantly to the cost of production, many local industries use cheap, poorly designed packages (Essuman, 2007). Ofosu-Okyere *et al* (1997) reported that, in Ghana like other West African countries, the packaging industry is not highly developed as information on packaging is not adequately researched, documented and readily accessible. Consequently, a wide range of sentiments have been expressed about the status of packaging of food and beverage products made in Ghana. Though these concerns are genuine and some of the opinions may be true, there is however very limited empirical evidence to convincingly substantiate it and thus the need to carry out this survey on that assertion (Mante, 2005).

Fresh Taste, a natural, refreshing and nutritious orange drink product is manufactured by Fruits and Flavours Limited, Asebu in the Central Region of Ghana. Due to the use of predominantly natural ingredients, minimal amounts of preservatives for its formulation and the exclusion of pasteurization in the processing, the product has a relatively short shelf life. The primary package of Fresh Taste which is a high-density polyethylene (HDPE) plastic sachet is perceived to be poorly and ineffectively designed, particularly its aesthetic appeal and seal integrity. Marketability of Fresh

Taste in the HDPE sachet is therefore low amongst the urbane and choosy category of people in Ghana who may want to patronize the tasty and refreshing product. This is perceived to be due to the packaging design in use as evidenced in its limited acceptance for sale by supermarkets (Letsinam, 2005). The seal quality is also perceived to be ineffective thus the product is vulnerable to leakage, contamination and deterioration due to imperfection in the form-fill-seal packaging facility in use at the factory. Because products such as unpasteurized fruit juices and fresh dairy products are consumed within short periods after production, the influence of packaging on product stability has not been adequately studied and has thus often been based on model systems (Van Willige *et al.*, 2000). Besides, only few studies have reported the influence of packaging on sensory properties of beverages (Pieper *et al.*, 1992; Van Aardt *et al.*, 2001). However, more studies have been devoted to products with long storage time such as pasteurized orange juice (Berlinet *et al.*, 2005). There is therefore the need to explore ways to overcome these limitations of Fresh Taste. This may be achieved by evaluating and understanding the impact of an alternative package design on the product quality, shelf life and marketability of the orange drink product. Information available shows that, very little work has been done in Ghana in the area of impact assessment of packaging design on the marketability and shelf life and quality of most food and beverage products made in Ghana (Mante, 2005). Moreover, the information available has either not been adequately documented or readily accessible to food manufacturers and related agencies in Ghana (Mante, 2005).

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Food Packaging

Packaging has been defined by different authors (Robertson, 1993; Piane and Paine, 1983). According to the United Kingdom Institute of Packaging (1992), it is a techno-economic function aimed at minimizing cost of delivery whiles maximizing sales. However, for a working and functional definition, food packaging can be described as an applied science that integrates the essence of containment, protection/preservation and communication of the attributes of a given food product, taking cognizance of the modern culture of convenience of the end user or retail consumer at minimal cost (Encarta, 2004).

2.2 Economic Value of Packaging

The estimated value of packaging materials and machinery used for packaging throughout the world is about £270 billion (Encarta, 2004). In the ECOWAS sub-region alone, the number of stakeholders of the packaging industry is over 200 million, and the total value of sales of packaging products is estimated to be over two billion US dollars (Boga-N'guessan, 2005). It is estimated that 50% of food production in the West African sub-region is wasted due to lack or inadequate packaging systems (Boga-N'guessan, 2005). About 60 per cent of all packaging materials is used for food and beverages given that the food industry is the largest user of packaging at the consumer level (Encarta, 2004; Piane and Paine, 1983). Furthermore, the fact that an average of around 25% of the ex-factory cost of consumer foods is for their package provides the incentive and challenge for food packaging technologists to design and develop functional packages at minimum cost (Robertson, 1993).

2.3 Historical Overview of Food and Beverage Packaging

Human beings have always protected food and drink in containers using skins, leaves, and gourds, and then baskets, pots as early as 1500 BC (Encarta, 2004). The beginning of modern packaging is tied to food preservation methods. Early methods included salting and smoking. Napoleon offered a prize to anyone who could invent a method of food preservation. It was a confectioner, Nicholas Appert, who won the prize for his method, which used airtight glass bottles. Later he used containers made of tinplate (tin-plated iron). This was the beginning of canning, which others developed further. However, much of the packaging development over the last 25 years has been due to the influence of plastics on almost every conceivable type of multi-component packaging (Piane and Paine, 1983).

2.4 Packaging Materials and Designs

Olympio and Kumah (2002) stated that, the packaging industry in Ghana is not very much developed except those for industrial and export produce. The basic materials used for packaging are paper and cardboard, plastics, aluminium, steel, glass, wood, regenerated cellulose film, textiles, or combinations such as laminates. Globally, the most widely used consumer package for aseptic products is the paper-based carton which is used for many beverages such as fruit juices (Robertson, 1993). Forms or designs of packaging include cartons, boxes, wrappings, bags, pouches, sachets, cups, sacks, trays, blister and skin packs, bottles, jars, cans, tubes, aerosol spray cans, drums, crates, and bulk containers. Opening methods include caps, corks, ring-pulls and tear-strips for primary packages. Labels, shrink sleeves or the package surface itself are used for printed identification of contents and marketing graphics (Encarta, 2004).

In developed countries, packaging technology is highly advanced and the materials and designs are made to suit the market and storage conditions (Olympio and Kumah, 2002). Packaging design seeks to address certain aspirations of the manufacturer such as increased sales (thus higher profits), greater market share, reduced packaging costs, faster market reactivity, increased distribution, re-focused consumer perceptions and new product introduction. Flexible materials are used as the sole component of a small package. These include paper, aluminium foil, moisture-proof cellulose film and plastic materials (Robertson, 1993).

Packaging can be classified into primary, secondary, tertiary and quaternary groups. Primary packages have direct contact with the contained product such as beverages in metal cans. Secondary packages contain a number of primary packages such as bottled products in cardboard boxes. Tertiary packages contain a number of secondary packages and quaternary packages contain a number of tertiary packages such as metal containers up to 12m in length (Robertson, 1993).

2.5 Functions of Food Packaging

There are four major functions of food packages namely protection, communication, containment and utility or convenience. Other ancillary functions include unitization, pilferage deterrence or tampering and apportionment.

2.5.1 Protection

The protective functions include all the package attributes which act to shield the packaged product from mechanical or physical, chemical and biological hazards in the environment and vice versa (Dalzell, 1994). The protective function of food packages may be designed against dust, dirt, microorganisms, light, excessive heat, oxygen, shocks, vibrations, electrostatic charges, ultraviolet light, moisture, carbon dioxide, flavour compounds and organic vapours.

2.5.2 Containment

Containment allows a product to be moved from one place to another as a unit and is obviously absolutely necessary for products that are liquids, gases or fine particles (Dalzell, 1994).

2.5.3 Convenience

Modernization of society leads to changes in consumer lifestyle thus packaging also responds with designs that make product convenient to use in terms of handling (easy-carry), apportionment, unitization, recyclability, non-breakability, tamper-proofing, child-proofing, portion control, packing for distribution or storage, easy-opening, serving or dispensing and disposal (Robertson, 1993).

2.5.4 Communication

The communication function of packaging essentially involves identification of the product, graphic appeal to the senses of the consumer or potential buyer, informing and educating the consumer on the utilization and source of the content and any other information needed such as production date, expiry date and nutritional profile. A suitable package must sell what it protects and protect what it sells thus fulfilling the essential role of a silent salesman on the shelves (Robertson, 1993). Labels on packages are important components of the overall marketing mix and can support advertising claims, establish brand identity, enhance name recognition and optimize shelf space allocation. Labels may be made as an attachment to the package from paper, cloth or other materials or can be embossed directly unto the package be it primary, secondary, tertiary or quaternary using heat, pressure or ink (Encarta, 2004).

Nutritional labeling of foods is a legal requirement in many countries, and the format in which the information is given is generally prescribed by law. In addition to compulsory labeling, many manufacturers voluntarily include other information, such as noting that the product is suitable for vegetarians, free from wheat gluten (and hence suitable for people with coeliac disease), kosher (conforming to Jewish dietary law), pareve (containing neither meat nor milk, conforming to Jewish dietary law), or Halal (conforming to Islamic dietary law). It is required that the shelf life of packaged food products is communicated on the label. This may be expressed explicitly or otherwise as the date of manufacture, date of packaging, sell-by-date, date of minimum durability (best before), use-by date, expiration date or recommended last consumption date (Robertson, 1993).

2.6 Packaging Technology

Ofosu-Okyere *et al.* (1997) reported that, the degree and extent to which packaging is carried out varies from nation to nation depending on the level of development, the level of industrialization and the culture of the people.

2.6.1 Plastic Packaging Technology

Plastic is a generic term used to describe an arbitrary group of materials based on synthetic or modified natural polymers which can be formed to shape by flow aided in many cases by heat and pressure during its manufacture. A range of plastics and co-polymers are used in the manufacture of plastic packages. In most developing countries such as Ghana, the common materials used are plastic-based such as polypropylene, polyethylene, polyvinylchloride (PVC) and polyethylene tetraphthalate (PET) (Fellows and Axtell, 1993). Blow-moulded plastic bottles have been used for many years as a cheaper alternative to glass for non-returnable containers. The use of High Density Polyethylene (HDPE) bottles is thus a practice common in developing countries mainly due to cost. HDPE has a much linear structure than LDPE and thus has up to 90% crystallinity, compared with LDPE which exhibits crystallinity as low as 50%. HDPE films are stiffer and harder than LDPE and densities range from 941-965 kg/m^3 (Robertson, 1993). HDPE have a melting point of 138°C whiles LDPE melts between 120-122°C. HDPE film offers excellent moisture protection, a much decreased gas permeability compared with LDPE film, but is much more opaque (Dalzell, 1994).

Low Density Polyethylene (LDPE) is the largest volume single polymer used in food packaging in both the film and blow-moulded form (Robertson, 1993). LDPE is a tough, slightly translucent material which can be blow-extruded into tubular film, or extruded through a slit die and chill-roll cast, the latter process giving a clearer film. It has good tensile strength, burst strength, impact resistance and tear strength. It is one of the most inert polymers and constitutes no hazard in normal handling (Robertson, 1993). The softening point of LDPE is just below 100°C, thus precluding the use of steam to sterilize it in certain food packaging applications. It is an excellent barrier to water and water vapour but not gases. It has excellent chemical resistance, particularly to acids, alkalis and inorganic solutions, but is sensitive to hydrocarbons, and to oils and greases. It has the ability to be fusion-welded to itself to give good, tough, liquid-tight seals. It is applied in rigid packaging material widely used in the form of snap-on caps, collapsible tubes and a variety of spouts and other dispensers (Dalzell, 1994).

2.6.2 The 'Micro-Dose' Packaging Technology

In Africa, the 'micro-dose' concept or packaging technology is potentially the ideal solution for mass distribution of basic consumer products such as butter, milk, fruit and vegetable products, table oil, sugar and vinegar (Boga-N'guessan, 2005).

The term micro-dose embraces an entire range of solutions covering small bottles, small cans and pots, collapsible tubes, and especially for the African market small sachets formed and filled on automatic form-fill-seal machines. Micro-dose packaging concept is the most economical, practical and hygienic alternative to bulk packaging in developing countries. The micro-dose concept is premised on putting the right quantity at the right price within reach of the poorest segments of society. The principal qualities sought in the African micro-dose are economic, pack integrity and the ability to withstand handling abuse (Boga-N'guessan, 2005). This technology is far more practical and hygienic than hand-filling small preformed plastic bags, and opens the way for the use of high quality graphics at an affordable price. Three governing principles for micro-dose pack design for Africa suggested by Boga-N'guessan (2005) are;

1. Pack size to match unit dose needed

2. Pack selling price fixed to common denomination coin

3. Pack size far removed from conventional pack sizes.

2.7 Package Selection Versus Optimal Design

There are almost an infinite number of combinations of packaging materials and designs that could be considered for packaging food and beverage products. Some choices are impractical since a balance has to be drawn between cost and function. The overriding goal of package design is generally the selection of the optimum package that will offer the greatest economic benefit (Dalzell, 1994). The influence of communication and utility functions of a package in selecting an optimum package design is more multifaceted unlike protective function. Hisrich (1990), identified 8 major requirements that dictate the packaging mix which can be grouped into five functional criteria namely in-home, in-store (or warehouse), production, distribution and safety laws. The package must protect the product, be adaptable to production line speeds, promote the product density, help the consumer use the product, provide reusable value to the user, satisfy legal requirements and keep packaging-related expenses low. The overall packaging cost is made up of:

- Packaging material cost (delivered at factory)
- Storage and handling cost of empty packages or materials
- Filling cost (including quality control and handling of filled packages)
- Storage cost of the filled packages
- Transport costs of delivering filled packages
- Losses due to breakage or spoilage
- Effect of package on sales figures (Paine and Paine, 1992).

A strong correlation exists between the influence of the communication and utility functions of the packaged product and the consumer's purchasing decisions (Dalzell, 1994). This can however be resolved appreciably by test marketing. An economic relationship can be calculated, showing overall package and product system costs to be lowest at some intermediate package costs where product protection is sufficient and package costs are not excessive (Dalzell, 1994). Quantitative economic analysis and estimates can sometimes prove difficult to do. However, a qualitative approach using a function-environment grid is a suitable alternative. It is a two-way anecdotal system or matrix that relates function to packaging environment employed usually by packaging experts (Robertson, 1993). Every package performs its functions within three environments namely physical, ambient and human packaging environments. Physical environment refers to the environs in which physical damage could be caused to the product such as vibration during transportation, compression and crushing during warehousing and shock from dropping. Ambient environment refers to the environment immediately surrounding the package such as gases (oxygen, carbon dioxide), water vapour or moisture, light, heat, cold, microorganisms and macro-organisms. The human environment refers to the environment within which the package interacts with people. A good packaging design considers human limitations and capabilities especially the visual and physical strength of consumers as well as legislative and regulatory requirements. The function environment grid or matrix involves discretionary or subjective evaluation of the suitability or performance of any given packaging design by packaging experts. This matrix enables the development of optimum, real and cost-effective packaging designs. As shown in Table 2.1, a percentage scale for instance could be used to assign scores to the intersections on the grid as a basis of performance measurement.

Table 2.1: **The function-environment grid or matrix for evaluating package performance or suitability**

	ENVIRONMENTS			
FUNCTIONS		Physical	Ambient	Human
	Convenience	60%	70%	50%
	Protection	X%	Y%	Z%
	Containment			
	Communication			

The percentage scores (such as X%, Y%, Z% in Table 2.1) assigned by a panel of packaging design experts for the various designs, determine the most optimum design to be adopted for use. Separate grids could be laid out for distribution package analysis, corrugated package analysis, regulatory or legal impact and environmental (natural) impact analysis or for any mix of package related concepts of interest to the designer.

2.8 Effect of Used Packaging on the Natural Environment

Every package eventually becomes waste after use. It is estimated that packaging waste constitute about 25% of all municipal solid waste (Boga-N'guessan, 2005). Disposal of this huge amount of wastes incurs cost to local governments, consumers and businesses. Improper disposal of packaging waste on the other hand, becomes a nuisance especially plastics and glass which are known to be non-biodegradable. Burning of such wastes as the case is in developing countries generate enormous amounts of toxic fumes into the atmosphere contributing to global warming. Package wastes from metals also tend to degrade into toxic chemicals that seep through landfills into the water table thus affecting plant and human lives. The enormous demand and therefore production of food packages continue to deplete the natural resources such as metal ore, paper pulp, rubber, wood and earthenware as a result of the utilization of such resources for the production of packaging materials. Used packages can however be collected and recycled into new bottles, paper, films, and cans. Environmental considerations have resulted in a trend to make packages as light as possible without impairing its protective properties (Dalzell, 1994). Lighter packages require less energy for transportation, thus reducing the environmental impacts from energy production and use. Lightweight of primary packages provides an obvious environmental benefit in reduced material use and is at the top of the waste management hierarchy (Robertson, 2006).

2.9 New Food Product Development (NFPD)

Value-added food and beverage products are fresh or semi-processed commodities whose worth have been increased through the addition of ingredients or processes that make them more attractive or appealing to the buyer and readily/easily useable by the consumer. Value-added products have some convenience quality or other positive features that give the consumer greater satisfaction (economic utility) than the original or previous product (Baker *et al.*, 1988). Thus some value-added food products are described as convenience foods which refer to partially or fully prepared food items that have been combined, processed and/or cooked by the manufacturer with objective finishing instructions so that only minimal amounts of preparation time are required in the home (Baker *et al.*, 1988). A new food product includes:

- an already existing food product that has been repacked and given a new name and/or image
- an improved or reformulated old product that may have new packaging and/or brand name
- a completely new formulation that serves an unsatisfied need of consumers, thus a line extender for the producer (Baker *et al.*, 1988).

2.9.1 Motivational Factors for the Development of New Food Product

The development of new food products as a core function of the research and development unit in any food manufacturing company or university food research laboratory is usually motivated by some of the following factors;

(i) Upgrading or improving the quality of the food product: The quality attributes of foods which are readily and easily perceptible by consumers are the sensory or organoleptic properties such as texture, appearance and flavour (taste and aroma). An exploration of possible ways of improving upon such sensory attributes may lead to the development of a novel product. Other quality attributes that could be explored include nutritional quality, storage quality (shelf life), etc.

(ii) Maximizing Profitability: Cost-benefit analysis or economic feasibility analysis of the inputs of production and distribution to the ultimate consumer need to be evaluated with consideration of parameters such as potential selling price, gross profit margin, break-even point, distribution cost, raw material cost, packaging cost, labour cost, cost of utilities among other things on the basis of estimated annual production capacity per unit (economy of scale).

(iii) Revamping the product image and/or brand acceptance beyond the maturation phase of its marketing life cycle since every product evolves through the embryonic, growth, maturity and decline stages.

(iv) Growing and ensuring competitiveness through technological innovation.

(v) Responding to changes in consumer eating patterns and habits to meet unsatisfied needs and/or wants.

(vi) Responding to changes and shifts in demographic characteristics (market changes) of the populace (Baker *et al.*, 1988).

2.9.2 The Consumer in New Food Product Development (NFPD)

Everyone who pays for products and services is described as a consumer. Market research focuses principally on identifying the needs and wants of the targeted group of consumers it wants or needs to reach. The background of consumers such as gender, income, education, age, ethnic group, social status, employment status, health status et cetera have a strong correlation with the expectations and perceptions of the consumers regarding food and beverage products (Baker *et al.*, 1988). Some of these expectations include product price, shelf life, convenience (easy-opening, easy-closing, retail unit or quantity per unit and easy disposal), availability, reliability, authenticity (naturalness), nutritional value, sensory properties, etc.

2.9.3 New Food Product Marketing

Marketing plays an important role in the development and sale of new food and beverage products. The American Marketing Association defines marketing as the process of planning and executing the conception, pricing, promotion and distribution of ideas, goods, and services to create exchanges that satisfy individual and organizational objectives (American Marketing Association, 1994). Economic utility of a product ensures satisfaction of some needs of consumers. A product that can satisfy buyers has more economic utility than a product that is of little or no use to anyone in a given marketing mix.

2.9.3.1 Marketing Mix

Marketing mix constitutes a framework that may be utilized to develop a simple marketing plan for a new product (Papadopoulos *et al.*, 2004). The basic categories of marketing mix elements are product, price, place (distribution), and promotion. These are commonly referred to as ‘4Ps of marketing’ since practically every possible marketing activity can be placed in one of these categories. New product marketing strategy includes such activities as selecting brand names, designing packages, and developing new products or appropriate warranties and service plans. Determining how a new product would get to the customer, how quickly, and in what condition, involves place or distribution strategy. Transportation, storage, materials handling, and the like are physical distribution activities. A channel of distribution is the complete sequence of marketing organizations involved in bringing a product from the producer to the user. A new food and beverage product requires promotion to communicate the novelty to potential customers. Advertising, personal selling, publicity, sales promotion, and merchandising are all forms of communication that are utilized to inform, to remind, or to persuade consumers. The messages that are communicated refer to information about the other three elements of marketing mix. For example, communication may suggest new uses for an existing product, it may advertise the low price offered during a sale period, or it may notify prospective buyers of a new retail location at which the company's products are now available (Papadopoulos *et al.*, 2004).

2.9.3.2 Marketing Environment

Every marketing mix is influenced largely by the marketing environment of the target markets. These include external elements such as competitors, economy, nature, politics, regulations, technology and society (Bovee and Thill, 1992). These external forces can affect the products that can be sold, how they are sold, and who can buy them within the context of ethics and social responsibility. Environmental scanning allows for data gathering on the marketing environment from people such as customers, salespersons, dealers or brokers, distributors, suppliers, government agencies and publications such as magazines, newspapers and books. Interpretation of all the data gathered could then assist in the development of strategies to mitigate the impact of changes in the marketing environment (Bovee and Thill, 1992). Significant cognizance of the marketing environment of packaged refresher drink products on the Ghanaian market is necessary to succeed in introducing a new food and beverage product. The marketing environmental factors that may be considered include competition (influx of artificially flavoured refresher drink products), economy (effective purchasing income and power of consumers within the target market as well as their willingness to spend on beverage products), natural events or phenomena (dry season being the peak period of consumption of refresher drink products), regulatory, technological and social elements such as increasing consumer right awareness and changing habits towards consumption of 'healthy' food and beverage products (Bovee and Thill, 1992).

2.9.4 New Food Product Pricing

The ultimate aim in marketing a new product is to maximize profit or maximize ones market share. In determining the price of a new product, it is important to determine the relationship between the sales volume and the product price. Gross margin percentage refers to the difference between cost and selling price expressed as a percentage of the selling price. It is a measure of the profitability (Dean, 1976). There are two main pricing strategies or philosophies namely:

1. Skimming pricing: It involves forsaking product demand for high selling price. This approach allows the producer more time to analyze the true market demand and the cost of distribution and advertising and thus expand the market share by reducing price to a point where gross margin is maximized (Dean, 1976).

2. Penetration pricing: It is suited to new products for which no elite market exists, or it is likely that new competitive products will be quickly introduced. A penetration strategy involves low initial pricing (low % gross margin) in order to develop high demand and inhibit competitive product development quickly which may then prevent competitors from introducing a competitive new product thus enabling recuperation of development cost. This can however lead to some losses (Dean, 1976).

2.9.5 Marketing Research in New Food Product Development

Marketing research, the systematic and objective process of gathering, recording, and analyzing data for marketing decision making is a critical undertaking in the development of new food and beverage products (Papadopoulos *et al.*, 2004). Additionally, marketing research is not restricted to only product information but also used to facilitate decision making bothering on the elements of the marketing mix. Marketing research can be classified into three on the basis of the purpose for undertaking the research.

2.9.5.1 Exploratory Market Research

The principal purpose of exploratory marketing research is to clarify and explain the nature of marketing problems. A company's declining sales is a symptom of a problem and the reasons why people are buying less than before must be found (Papadopoulos *et al.*, 2004).

2.9.5.2 Descriptive Marketing Research

This is undertaken in an effort to describe the nature of a market or of some marketing problem without attempting to explain the characteristics observed or portrayed in such a study. Performance monitoring research is a special type of descriptive marketing research which provides a continuous flow of information (market feedback). Organizations monitor sales and marketing activities to ensure detection of sudden changes in sales, as well as other abnormalities. Much of the data needed to track sales performance can be obtained and analyzed from internal sales records (Papadopoulos *et al.*, 2004).

2.9.5.3 Causal Marketing Research

Causal marketing research is designed to identify factors that cause certain market phenomena. Thus it seeks to identify cause-and-effect relationships among market variables. For instance the relationship between price cuts and sales or between advertisements and orders received for one's products would be suitably investigated by a causal marketing research (Papadopoulos *et al.*, 2004).

2.10 Market Research by Survey

Research by survey is the most common technique for obtaining primary data. A survey is any research effort in which information is gathered systematically from a sample of people by means of a questionnaire (Papadopoulos *et al.*, 2004). Questionnaires are used to assess the response of the people by mail, telephone or in person. These may be preceded by a focused group discussion to elicit ideas and perceptions from a selected group of persons possessing certain relevant attributes. This helps to come up with the right questions to solicit relevant answers. A proposed questionnaire, or 'interview script', might be tried out on a small sample of respondents in an effort to make sure that the instructions and questions are clear and comprehensible. Pre-testing provides the researcher with a limited amount of data that can be used to develop an idea of what to expect from the upcoming full-scale study. In some cases, this data will show that the study is not answering the researcher's questions, and the study may then have to be redesigned (Papadopoulos *et al.*, 2004).

When undertaking marketing research by survey, the advice of the renowned mathematician John Tukey, that it is far better to have an approximate answer to the right question than a precise answer to the wrong question, is of utmost importance (Bovee and Thill, 1992). There are however, two types of errors associated with survey research namely sampling and systematic errors. Sampling error is a statistical phenomenon which occurs because of chance variation (Papadopoulos *et al.*, 2004). It refers to the difference between a sample value of some variable and the population value of the same variable. Increasing sample size though expensive and sometimes not feasible, tends to minimize sampling error. Carelessness or ignorance can lead to the selection of samples that are simply not representative of individuals or companies in which a researcher is interested (Papadopoulos *et al.*, 2004). Systematic or non-sampling errors arise from the design or execution of the research such as poor wording of questions, incorrect answers by respondents due to misunderstandings, or misinterpretation of results by the researcher. It is in the interest of the researcher to verify the availability of secondary data before undertaking primary data collection to save cost and time. However, secondary data may be unreliable because it may be outdated or may not have been collected in the preferred form. Classical sources of secondary data include journal reports, population census and company sales data (Papadopoulos *et al.*, 2004).

2.10.1 Population Concepts and Terminologies

Sample population refers to the entire group of possible respondents to a survey questionnaire. Sampling unit refers to the element or set of elements considered for selection in some stage of sampling such as blocks, households and individuals. Sample frame refers to a list of the accessible population from which one draws the survey sample. Target population or population of interest refers to the set of people, products, firms, market and so forth that contains the information that is of interest to the researcher (Dillon, Madden and Firtle, 1990). The population of interest must:

1. be consistent with the objectives of the study
2. contain respondents that identify with the information sought by the survey
3. be clearly defined as to any other qualities that respondents should have in order to be included (or excluded).

2.10.2 Selecting a Sample

Sampling refers to any procedure in which a small part of the whole population is used to draw conclusions regarding the population. A sample is a representative portion of a larger population contrary to a census which is a survey of all the members. However, a sample does not have to be representative of the general population, but it must be representative of the population of interest or target population (Dillon *et al.*, 1990). The reliability of any sample is determined by the appropriateness of the sample frame, sample size and sampling unit(s). There are two basic types of sampling: probability and non-probability sampling. A probability sample is defined as a sample in which every member of the population has a known non-zero probability of selection. However, if sample units are selected on the basis of convenience or personal judgment, the sampling method results in a non-probability sample. Thus the researcher predetermines the pertinent sample characteristics and the data is collected so that it matches these pre-specified characteristics (Papadopoulos *et al.*, 2004).

2.10.3 Estimating Sample Size

Sometimes it is assumed that a larger sample is more representative than a smaller one and thus one should go for the largest sample size possible. That assumption is true to a large extent but the excess samples beyond a suitably representative threshold can be avoided. There are five main factors that influence the determination of sample size by a researcher. These include research hypothesis, the level of precision, the homogeneity of the population, the sampling fraction, and the sampling technique used (Monette *et al.*, 2002). Monette *et al.* (2002) presents a comprehensive table for calculating sample size based on confidence level, sampling error, population heterogeneity (50/50% and 80/20% distribution), and population size as shown in Table 2.2.

Table 2.2: Estimating Sample Size

Sample Size for the 95% Confidence Level						
Population Size	**±3% Sampling Error**		**±5% Sampling Error**		**±10% Sampling Error**	
	50/50 Split	**80/20 Split**	**50/50 Split**	**80/20 Split**	**50/50 Split**	**80/20 Split**
100	92	87	80	71	49	38
250	203	183	152	124	70	49
500	341	289	217	165	81	55
750	441	358	254	185	85	57
1,000	516	406	278	198	88	58
2,500	748	537	333	224	93	60
5,000	880	601	357	234	94	61
10,000	964	639	370	240	95	61
25,000	1,023	665	378	234	96	61
50,000	1,045	674	381	245	96	61
100,000	1,056	678	383	245	96	61
1,000,000	1,066	682	384	246	96	61
100,000,000	1,067	683	384	246	96	61

Source: (Monette *et al.*, 2002)

2.10.4 Data Analysis

Data analysis usually involves three processes namely editing, coding and analyzing. Editing involves checking for omissions, incomplete or otherwise unusable responses, illegibility, and obvious inconsistencies. This may result in discarding some data collected. The process may also uncover correctable errors such as the recording of a usable response on a wrong line of a questionnaire. Coding involves the establishment of meaningful categories so that responses can be grouped into usable classifications, especially with a view towards computer analysis of alphanumeric data (Monette *et al.*, 2002).

2.10.5 Some Population Characteristics of Ghana and KNUST Campus

According to the Information and Communication Technology for Accelerated Development (ICT4AD) document issued in June, 2003 by the Government of Ghana, the country has a relatively youthful population with close to 60% of the population under the age of 25. KNUST campus is presumed to be suitable as a defined test community for a national survey (miniature Ghana) because it has a fairly similar and cosmopolitan demographic outlook as that of the general population of Ghana and it typifies a literate young adult population.

Table 2.3: Educational attainment of Ghana's population (2000)

Educational Level	**Percentage in Population (2000 Census)**
Postsecondary/Tertiary	**4.3%**
Senior secondary school/vocational/technical	**8.2%**
None/pre-school/primary/JSS	**87.4%**

Source: (Ghana Statistical Service, 2002)

According to the Ghana Population and Housing Census 2000, the estimated expenditure on food and beverages by Ghana's adult population with regards to income levels is about 45.4% of household expenditure. The ICT4AD document further indicates that close to 40% of Ghanaians in 2003 lived below the poverty line of less than a dollar a day. These statistics are pointers of a low purchasing power of the Ghanaian adult population and thus the youth, may not be able to spend much on food and beverage products that are perceived to be expensive. The student population of the campus of the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi was estimated to be 19,854 in 2005.

The population is made up of about 29% females, 71% males and a fairly commensurate composition of students from all the 10 regions of Ghana (Anon., 2005). The predominant age group is between 17 and 40 years with those above 40 years as minority. The literate youthful age group (17-40) of most societies typically has a fast and exuberant lifestyle. Thus they have a higher propensity to patronize processed food and beverage products packaged attractively (convenience food) with an enquiring disposition with regards to quality of product, safety, price, packaging, nutritional value, expiry date and retail units. Majority of the KNUST students are presumed to be unemployed but possess a significant level of purchasing power as most of them receive satisfactory stipends from their sponsors. The educational status of KNUST students places them well within the enlightened patrons of packaged food and beverage products with an appreciable level of expendable income for packaged refresher drink products out of the general population of Ghana. The basis of the average estimate is drawn from the:

(i) Literacy level of Ghana's adult population expressed as those who have secondary or higher qualification (about 12% according to Ghana Population and Housing Census 2000). Presumably, the more educated one is, the higher the propensity to have an enquiring disposition especially in purchasing a packaged refresher drink product (Mante, 2005). The technical nature of information and knowledge of the subject of food product packaging require respondents with an appreciable level of education for this survey.

(ii) Income levels and expenditure on food and beverage products by Ghana's adult population which is about 45% according to reports of the Ghana Statistical Service (GLSS IV) and the Ghana Population and Housing Census 2000. The presumption is that, the proportion of disposable or expendable incomes on food and beverage products most likely would correlate positively with the income level of the respondents.

2.11 Fruit Juice-Based Food and Beverage Products

Fruit juice is defined as the unfermented but fermentable juice, intended for direct consumption, obtained by a mechanical process from sound, ripe fruits (Fellows, 2000). The juice may be turbid or clear. Grape, apple and blackcurrant produce clear clarified juices. Light cloud juices are obtainable from pineapple whiles heavy cloud juices containing cellular material in suspension can be sourced from fruits such as orange and grapefruit. Pulpy juices are obtained from fruits such as tomato and banana (Robertson, 1993). The juice may be concentrated and later reconstituted with water suitable for the purpose of maintaining the essential composition and quality factors of the juice (Fellows, 2000). The incorporation of food additives in formulations are permitted but must be endorsed in the pertinent food standards. Fruit juice and its derivatives can be classified as a concentrate, nectar, drink, syrup, cordial, etcetera, depending on its composition (Kirk and Sawyer, 1991). Concentrated fruit juice refers to an unfermented product, which is capable of fermentation after reconstitution, obtained from the juice of sound, ripe fruits, from which the water has been removed to the extent that the product has a soluble solid content of not less than double the content of the original juice intended for direct consumption (Fellows, 2000). Fruit nectar refers to an unfermented but fermentable non-pulpy or pulpy product, intended for direct consumption, obtained by blending the fruit juice and/or the total edible part of sound, ripe fruits, concentrated or unconcentrated, with water and sugars or honey (Fellows, 2000). Fruit puree is the unfermented but fermentable product obtained by appropriate processes such as sieving, grinding and milling of the edible part of the whole or peeled fruit without removing the juice. Robertson (1993), explained that there are three categories of juices from the packaging point of view, namely single strength (10-13°Brix), concentrated juices (42 or 65°Brix) and nectars (20-35°Brix). Concentrated fruit purée may be obtained by the physical removal of water from the fruit purée (Fellows, 2000).

Most industrially processed fruit juices that appear on the retail market are derived from citrus fruits (Kirk and Sawyer, 1991). Fruit juices are consumed for their characteristic flavour and are also considered sources of vitamins, minerals and soluble and insoluble fibres (Righetto *et al.*, 1999). Some of the physicochemical parameters determined for quality assessment of fruit juice products include acidity, pH, refractive index, soluble solid or sugar content as sucrose and bulk density. The acidity of fruit juice is usually calculated based on the predominant acid that is, citrus juices as citric acid, apple as malic acid and grape juice as tartaric acid. The flavour of fruit juice is related to the ratio of soluble solid to the total acidity called the maturity ratio, which increases as the fruit ripens and is sometimes used for assessing the quality of the juice (Kirk and Sawyer, 1991). Kirk and Sawyer (1991) reported the total titratable acidity expressed as citric acid of orange juices from various sources as ranging from 0.4% minimum to a maximum of 3.5% with a mean value of 1.4%. Titratable acidity also know as total titratable acidity is a measure of all hydrogen ions free in solution, bound to dissociated acids and bound to anions. The refractive index of a sugar solution is a direct measure of its concentration. Solutions of different sugars of equal concentration have approximately the same refractive index at 20°C (Leonard *et al.*, 1987). The ease and speed with which the refractive index of a sugar solution can be determined makes this a convenient method for determining the sugar content, and indirectly the water content of solutions containing sugar. Consequently, the refractometer is widely used for quality inspection in the manufacture of syrups, jam, fruit juices and other food products (Aurand *et al*., 1987).

2.11.1 Deteriorative Reactions of Fruit Juice Products

Citrus juice stability depends on the characteristics of the raw material, processing conditions, packaging material and distribution or storage conditions (Correa de Souza *et al*., 2004 and Robertson, 1993). These factors may cause microbiological, enzymatic (biochemical), chemical and physical changes that damage the sensorial and nutritional characteristics of the product. Robertson (1993) reported that the rate of browning and nutrient degradation in fruit juices is largely a function of storage temperature, although the rate is in part dependent on the packaging material. Pasteurization of low-pH food products such as orange juices has proven adequate as means of controlling microflora at relatively low temperature-short-time thermal processing (80°C for 30s). Pasteurization also helps in cloud stabilization of certain juices (orange, grapefruit and tomato) by inactivating pectinesterases. The oil fraction of citrus juices contains many aromatic volatiles which are relatively oxidized with ease resulting in undesirable terpene-like off-flavours. Deaeration prior to packaging reduces flavour deterioration.

The major changes that occur in foods during processing and storage affect the food quality. Robertson (1993) stated that, knowledge of the major biochemical, chemical, physical and biological changes that occur in foods during processing and storage is essential before a sensible choice of packaging material can be made. The choice of a good packaging material ensures product quality and safety in that, it provides a suitable barrier around the food against potential hazards and also precludes the migration of potentially harmful substances from some packaging materials into the food. Robertson (1993) reported that, orange juice aseptically packaged in low density polyethylene/foil/paper/polyethylene laminate cartons and glass containers within 35 days storage at 25°C, was found to have decreased the d-limonene content from 70ppm to 4ppm in the cartons whiles an experienced taste panel detected a significant difference between the orange juices in the cartons and glass after about 2.5 months. The limonene content was scalped by the polyethylene surface of the package. Ascorbic acid degradation and consequently browning were also accelerated due to contact with the polyethylene film. With the exception of nutritive value, the changes that occur in food quality attributes are readily apparent to the consumer, either prior to or during consumption. Quality and shelf life determination of orange juice is however strongly based on the Vitamin C evolution during storage although there are other quality parameters such as colour, flavour and microbial characteristics that are also very important (Lee and Coates, 1999).

2.11.2 Shelf Life of Fruit Juice-Based Products

The National Food Processors Association in the USA defines shelf life as the period of a product's state when the product is neither misbranded nor adulterated and when the product quality is generally accepted for its purported use by a consumer, and so long as the container retains its integrity with respect to leakage and protection of the contents. The Institute of Food Technologists in the USA defines shelf life as the period between manufacture and the retail purchase of a food product, during which time the product is in a state of satisfactory quality in terms of nutritional value, taste, texture and appearance (Robertson, 1993). The rate of deteriorative reactions are influenced by both intrinsic (compositional) and extrinsic (environmental) factors.

For the majority of foods and beverages in which quality decreases with time, it follows that there will be a finite length of time before the product becomes unacceptable. This time from production to unacceptability is referred to as shelf life (Robertson, 2006). In shelf life testing, there can be one or more criteria which constitute product failure. These include an increase or decrease by a specified amount in the mean panel score for sensory analysis based on physical changes with or without consumption with regards to the organoleptic attributes of the food product. Furthermore, the extent of microbial deterioration of the product sample which renders it unsuitable or unsafe for human consumption constitutes a criteria for product failure. Product failure thus refers to the condition of a product which exhibits either physical, chemical, microbiological or sensory characteristics that are unacceptable to the consumer, and the time required for the product to exhibit such conditions is the shelf life of the product (Robertson, 1993). Qualitative analysis of the deteriorative reactions in food otherwise expressed as shelf life requires the existence of a measurable index of deterioration be it chemical, physical or sensory. Changes in the index correlate with changes in the food quality. Robertson (1993) explained that, for quantitative analysis of quality changes in food, the index or measurable indicator must be expressed as a function of the condition existing during processing and storage so that the changes can be predicted or simulated. Thus, calculations of quality losses require a mathematical model for the product in question that expresses the effect of intrinsic and extrinsic factors on the deterioration index. Deteriorative reactions in food usually do not proceed at once and the different stages may have varying dependence on concentration and temperature leading to inconsistencies in kinetic data for predictive purposes. This is the case with chain reactions and microbial growth which have both a log and lag phase with different rate constants. Several approaches to determining shelf life of food products exist which include:

(i) Literature study: the shelf life of an analogous product obtained from the published literature or in-house company files

(ii) Turnover time: the average length of time which a product spends on the retail shelf is found by monitoring sales from retail outlets, and from this the implicitly required shelf life is estimated

(iii) End point study: random samples of the product are purchased from retail outlets and then tested in the laboratory to determine their quality on the premise that it has been exposed to actual environmental conditions.

(iv) Accelerated shelf life testing: laboratory studies are undertaken during which environmental conditions are accelerated by a known factor so that the product deteriorates at a faster rate than normal to quantify the effect of environmental conditions on product shelf life. The use of a sensory panel for the determination of shelf life is inevitable since product acceptability is the prerogative of the consumer (Robertson, 1993). Instrumental or chemical analysis may however be used to complement the outcome of sensory analysis, nonetheless human judgment remains the ultimate arbiter of food acceptability.

2.12 Orange Drink Product from Fruit and Flavours Limited

Fruit and Flavours Limited is a limited liability citrus fruit processing company located at Asebu in the Central Region of Ghana. The company processes lime fruit into concentrates (lime flavour) for export. The company also processes orange which is a perennial fruit into a single strength re-constituted drink, pineapple into a single strength re-constituted drink and another non-carbonated beverage from artificial cola flavour (Letsinam, 2005). 'Fresh Taste' is a natural, refreshing and nutritious orange drink product manufactured by Fruits and Flavours Limited. Due to the use of predominantly natural ingredients and minimal amounts of preservatives for its formulation, it has a relatively short shelf life. The product is primarily packaged in a high density polyethylene (HDPE) sachet with a 2-colour (red and orange) graphic design print-out in 170ml and 350ml portions using the form-fill-seal packaging technology. The secondary package is a HDPE bag which contains 50 sachets of the 170ml and 25 sachets of the 350ml portions. The product is widely distributed in Ghana appealing mostly to school children and low-income earning adults as a refreshing drink mainly because of the price and packaging. Interestingly, it is also enjoyed by many adults outside its predominant patronage group but the current package does not appeal to such adults especially the middle to high income earners who may want to patronize Fresh Taste upon tasting the product or knowing its nutritional and natural attributes (Letsinam, 2005). The product is vulnerable to contamination coupled with product losses between 10-40%. The standard pH and sugar content of Fresh Taste are 4.2 at 25°C and 5.0% respectively (Letsinam, 2005). The main ingredients of Fresh Taste are natural orange juice extract, water, sugar, preservatives (E223-Sodium metabisulphite and E210-Benzoic acid) and colourants (E102-Tatrazine and E110-Sunset Yellow FCF). Some of the routine quality control tests carried out in the production of Fresh Taste are the determination of concentration of the preservatives, sugar content (Brix), microbial load (yeast/mould), pH, total titratable acidity (TTA %) and Vitamin C.

2.13 Common Additives of Fruit Juices

Food additives are substances added in limited quantities during food product formulation to supplement the ingredients of the food where they play essential functions such as preservation, acidity regulation, texture modification, emulsification, sweetening, foaming, nutrient enrichment and colour enhancement (Anon., 2008; Codex Alimentarius, 1992). They are assigned standard codes according to their functional classes by the Joint Committee on Food Additives of the Codex Alimentarius Commission.

2.13.1 Preservatives

Food preservatives operate predominantly by inhibition, although some preservatives additionally inactivate the inhibited microbes and other untoward changes in food (Russel and Gould, 1991). For instance, Sorbic acid acts against mainly yeast whiles Propionic acid acts principally against mould with little or no effect on yeast. Sulphur dioxide and its salts act against yeast, mould, bacteria and inhibit discolouration of food. Sodium metabisulphite (E233) is a widely-used food preservative which, when ingested, causes bronchoconstriction in some asthmatics. On inhalation it also causes cough. In solution, it forms the bisulphite ion and Sulphur dioxide gas (SO_2). The airway effects could be due to the release of the bronchodilator prostaglandin E2 (PGE2). Benzoic Acid (E210) is normally used in its alkali salt form because of the low solubility of the free acid. These include Potassium benzoate, Calcium benzoate and Sodium benzoate. Its activity is primarily against yeast and moulds rather than bacteria. It has higher activity at acidic pH values, leading to its use in acidic food and beverages (Aurand *et al.*, 1987; Gould, 1996).

2.13.2 Colourants

Colourants are used in food and beverage product formulation to enhance the visual appeal. Common colourants used in beverage formulation include Tartrazine (E102), Sunset Yellow FCF (E110), Carmines or Carminic acid (E120), Caramel I, II, III, IV (E150a,b,c,d) and Beet red (E162) (Aurand *et al.*,1987; Russel and Gould, 1991).

2.14 Food Quality and Safety

Food quality is the quality characteristics of food that is acceptable to consumers. This includes external factors such as appearance (size, shape, colour, gloss, and consistency), texture, flavour as well as other chemical, physical and microbial factors (Robertson, 1993). Food safety describes the absence of any component (contaminant) in a food product known to be harmful be it chemical (pesticides), biological (microorganisms), biochemical (metabolites) or physical (pieces of wood, metal, glass, etc) (Robertson, 1993). Food safety is also defined as the assurance that food will not cause harm to the consumer when it is prepared or eaten according to its intended use. Total quality and safety management embraces a broad spectrum of activities and systems with overlapping protocols such as Good Manufacturing Practices (GMP), Hazard Analysis Critical Control Point (HACCP), Good Agricultural and Collection Practices (GACP), Good Post-harvesting Practices (GPHP) (Robertson, 1993).

2.15 Food Standards and Legislation

The need for food standards and legislation in ensuring safety and quality cannot be overemphasized. Food standards are the body of rules directly concerning food and beverage products, whether they take official, semi-official or factory form. Food standards are justified in that they seek to protect the health and wealth of the consumer. They help to prevent the transmission of disease, limit the sale of unwholesome products, and simplify the marketing of food and beverage products locally and internationally. Food standards seek to protect consumers from consumption of unsafe food and ensure harmony amongst stakeholders of the food and beverage product industry by prescribing acceptable definitions, designations, composition, additives, safety and quality parameters (Codex Alimentarius, 1992). It also deals with issues on hygiene, measurements, packaging, chemical/pesticide residues (contaminants), sampling and analytical methods. The scope of food quality standards includes principal ingredients of the food, intrinsic sensory characteristics, origin of raw material, etc. Food standards are described in various ways to reflect the limits of their definitions. These descriptions of food standards include permissive, mandatory, prohibitory, presumptive, complete, partial, trading, regulatory, directive and commercial among others. Food laws and regulations are promulgated by specific agencies to regulate the production, processing, packaging, marketing and consumption of foods (Codex Alimentarius, 1992).

2.15.1 Regulatory Bodies of Food Standards and Legislation

The Codex Alimentarius Commission is an international intergovernmental body established under the constitution of FAO and WHO and thus forms part of the United Nations system of specialized agencies. It is responsible for the execution of the Joint FAO/WHO Food Standards Programme. Created in 1962 by FAO and WHO, the programme is aimed at protecting the health of consumers and facilitating international trade in food and beverage products. Codex Alimentarius (Latin, meaning Food Law or Code) is a collection of international food standards adopted by the Commission and presented in a uniform manner. It includes standards for all the principal foods, whether processed or semi-processed or raw. Materials for further processing into foods are included to the extent necessary to achieve the purposes of the Codex Alimentarius as defined. The Codex Alimentarius includes provisions in respect of the hygienic and nutritional quality of food, including microbiological norms, provisions for food additives, pesticide residues, contaminants, labeling and presentations, and methods of analysis and sampling. It also includes provisions of an advisory nature in the form of codes of practice, guidelines and other recommended measures such as the proactive quality and safety assurance tool called HACCP. Other international agencies that set food standards include Joint FAO/WHO Expert Committee on Food Additives (JECFA), European Commission (EU),World Animal Health Organization(Office International des Epizooties-OIE), International Plant Protection Convention(IPPC), Food Chemicals Codex Committee (FCCC) and World Trade Organization(WTO).

Ghana Standards Board (GSB) is the national statutory body responsible for the development and promulgation of Ghana Standards for local products and those for export. Ghana Standards Board is a member of the African Regional Organization for Standardization (ARSO) and the International Organization for Standardization (ISO). GSB is empowered by Article 2, NRCD 173, 1973 of the 1992 constitution of the Republic of Ghana to carry out certain functions including the standard specifications for products and processes as well as issuance of certificates to manufacturing companies when they comply with standards and regulations in production.

Food and Drugs Board (FDB) is the national statutory body responsible for the enforcement of Ghana Food and Drug Standards at the site of manufacture and products on the market or field. The Food and Drugs Board was established by the Food and Drugs Law 1992 (PNDL 305B) to control the manufacture, importation, exportation, distribution, use and advertisements of food, drugs, cosmetics, chemical substances and medical devices.

2.16 Microorganisms Associated with Fruit Juices

Microorganisms enter processing plants on the surface of fruits, having originated from soil, untreated water, dusty air and decomposed fruit. The low pH of citrus juices and concentrates limit the organisms that survive and grow. Microbial growth in citrus juice is characterized by the production of unpleasant flavours and product deterioration which is commonly caused by yeast (Parish, 1991). Lactobacillus and Leuconostoc survive and grow in orange juice whose pH range between 3.4 and 4.0 but fail to grow at 45 Brix. The various means available for combating the deleterious effect of microbes in food include prevention of their access to food, inactivation or extermination when they are present and inhibition of their growth should they have gained access (Russel and Gould, 1991).

2.16.1 Yeasts and Moulds

Yeast and moulds are fungal microorganisms widely distributed in the environment, and may be found as part of the normal flora of a food product, on inadequately sanitized equipment or as airborne contaminants. Although certain yeasts and moulds are useful in the manufacture of various foods such as mould-ripened cheese and bread, they also can be responsible for spoilage of many types of foods. Due to their slow growth and poor competitive ability, yeast and mould often manifest themselves on or in foods in which conditions are less favourable to bacteria growth. These include low pH, low moisture, low water activity, high salt or sugar content, low storage temperature, the presence of antibiotics and exposure to irradiation (Russel and Gould, 1991). Thermal death results upon a few minutes exposure to temperatures above 55°C for most yeast. There are about 12 strains of yeast found in citrus juices but predominantly the causative species of spoilage are usually apiculate yeast or ellipsoidal strains of Saccharomyces cerevisiae (Russel and Gould, 1991). The Ghana Standards Board prescribes a limit of 5.0 x 10^1 for yeast and moulds in juices preserved exclusively by physical means. Moulds are strict aerobes and thus usually found on surface of contaminated food. Yeast and moulds can utilize such substrates as pectin and other carbohydrate, organic acids, proteins and lipids. Additionally, yeasts and/or moulds can cause spoilage problems through synthesis of metabolites, resistance to heat, freezing, antibiotics or irradiation and their ability to alter otherwise unfavorable substrates allowing for the outgrowth of pathogenic bacteria. They may cause off odours, off flavours and discolouration of food surfaces. The classical method for the enumeration of yeasts and mould uses an acidified medium that inhibits bacterial growth (Russel and Gould, 1991).

2.16.2 Coliforms

The term ‘Coliforms, generally describes a broad group of bacteria collectively known as Enterobacteria. It is made up of species of small Gram negative non-spore forming rods that ferment glucose to produce acid or acidic gas within 48 hours at 32 to 37°C. They are oxidase-positive and some are motile. Most of them are commensals or parasites in the human and animal intestines. Escherichia coli are species of Coliforms of significant interest. This species is motile, produces acid and gas from lactose at 44°C and 37°C, Methyl Red positive, Voges-Proskauer positive and fails to grow in citrate (Russel and Gould, 1991).

These are the so-called ‘faecal coli’ that occur normally in the human and animal intestine and it is natural to assume that their presence in food indicates recent contamination with faeces. E. coli is however widespread in nature and although most strains probably had their origin in faeces, its presence, particularly in small numbers, does not necessarily mean that the food contains faecal matter (Russel and Gould, 1991). It does suggest a low standard of hygiene. It is associated with human and animal infections and is the commonest cause of urinary tract infections in humans and it is also found in suppuratine lesions, neonatal septicaemias and meningitis. In animals, it causes Mastitis (Russel and Gould, 1991). The enterobacteria are generally grouped into lactose fermenters which are saprophytic and non-lactose fermenters which are pathogenic (Russel and Gould, 1991). The Ghana Standards Board prescribes a limit of 1.0 x 10^2 for Coliforms in juices preserved exclusively by physical means.

2.16.3 Staphylococcus aureus

This organism is a common commensal in the nose and throat and on the skin of healthy people and animals, so that it may readily contaminate a wide range of foods. Different strains of S. aureus produce at least 6 well-defined and antigenically distinct enterotoxins (A, B, C, C_2, D, and E). Enterotoxin A is the most toxic and the most common type associated with food poisoning. Numbers in excess of 10^6 per gram are necessary for the generation of sufficient toxin to cause food poisoning (Atlas *et al.*, 1995). The Ghana Standards Board however, prescribes a limit of zero for Staphylococcus in juices preserved exclusively by physical means. Staphylococcal enterotoxin are heat-resistant, and so many survive in foods that have been heated sufficiently to inactivate the producer organism. Many foods can support the growth of S. aureus, aerobically or anaerobically but it does not compete well with other microorganisms, so that the raw foods are seldom implicated in Staphylococal food poisoning. Its low water activity tolerance allows it to form well with minimal competition in high salt foods. Its presence is detectable by the colour change from yellow in acidic medium to red in alkaline medium using phenol red indicator (Russel and Gould, 1991).

2.16.4 Enumeration Methods of Food Microbes

2.16.4.1 Direct Enumeration Methods of Food Microbes

Direct enumeration methods are based on the assumption that the microbial cells present in a sample mixed with a growth medium (agar) each form visible, separated colonies that can be counted or microbial biomass that can be measured by weighing whole cells (Atlas *et al.*, 1995). The colony or viable count per unit is calculated by multiplying the average number of colonies per countable plate by the reciprocal of the dilution (dilution factor). This is reported as colony forming unit (cfu) or viable count per unit sample ((Atlas *et al.*, 1995). The aerobic plate count method of microbial load estimation actually estimates the viable microbial colonies per unit of analyzed sample since bacterial cells occur in singles, pairs, chains, clusters or clumps. The counts obtained are reported as viable colony counts per unit or viable colony forming units per unit. The precision of APC technique is usually restricted to studies on bacteria and less to yeast because reliable estimates cannot be made when the yeast cells are actively dividing (Cook, 1958). However, colony count methodology can provide a useful tool for estimating microbial population in foods. The optimum medium (nutrients) and conditions (such as temperature and oxygen) for determining the colony count may vary from one food to another. However, once the optimum procedure for a given food is determined, it can be useful for routine microbial analysis of food (Atlas *et al.*, 1995).

2.16.4.2 Indirect Enumeration Methods of Food Microbes

The Most Probable Number (MPN) technique is an indirect statistical enumeration procedure based on probability theory. Samples are serially diluted to a point of extinction, that is, to a point where there are no more viable microorganisms. To detect the end point, multiple serial dilutions are inoculated into a suitable growth medium, and the development of some recognizable characteristics or changes such as acid production or turbidity, is used to indicate growth, that is the presence of at least one viable microorganism in the diluted sample (Atlas *et al.*, 1995).

To use the MPN procedure, at least 3 dilutions are needed. Theoretically, the least dilute tubes should be all positive and the most dilute tubes (of the 3 dilutions) should be all negative. This is not always the case, so the rule of thumb is to select the highest dilution in which all portions tested are positive (no lower dilution being negative), and the 2 succeeding dilutions are then chosen. The pattern of positive tests (growth) in the replicates and statistical probability tables are used to determine the concentration (MPN) of bacteria in the original sample. Statistical MPN tables are available for replicates of 3, 5 and 10 tubes of each dilution. The more replicate tubes that are used, the greater the precision of the estimate of the size of the bacterial population (Atlas *et al.*, 1995).

2.17 Sensory Evaluation

The Sensory Evaluation Division of the Institute of Food Technologists (1975), USA define sensory evaluation as the scientific discipline used to evoke, measure , analyze and interpret those reactions to characteristics of foods and materials as perceived through the senses of sight ,smell, taste, touch and hearing (Poste *et al.*,1991). Quality control and new food product development programmes employ human subjects as the most reliable, complete and meaningful means of measuring organoleptic characteristics of food though advances have been made in the development of instrumental tests that seek to measure individual quality factors (Poste *et al.*, 1991).

There are generally four groups of sensory panels namely highly trained experts, trained laboratory panels, laboratory acceptance panels and large consumer panels essentially based on the purposes of the sensory tests. Between 1 and 3 highly trained experts are suitable for the evaluation of quality of products with a very high degree of acuity and reproducibility such as wine, beer, tea, and coffee connoisseurs. Evaluations by experts and trained laboratory panels can be useful for control purposes, for guiding product development and improvement, and for evaluating quality. Between 10 and 20 panelists can be particularly suitable and useful in assessing product attribute changes for which there is no adequate instrumentation. Sensory analyses performed by laboratory acceptance panels (25-50 people) are valuable in predicting consumer reaction to a product. Large consumer panels (more than 100 people) are used to determine consumer reaction to a product (Poste *et al.*, 1991). Sensory evaluation also finds application in shelf life study of certain food and beverage products especially when it is difficult to obtain kinetic data of deteriorative reactions for predictive purposes. Such a situation is frequently the case for chain reactions and microbial growth which have both a lag and log phase with different rate constants.

2.17.1 Classification of Sensory Evaluation Methods

The three fundamental classes of sensory evaluation programmes include discriminative tests, descriptive tests and affective tests. Discriminative tests are used to determine whether a difference exists between samples or not. Descriptive tests are used to determine the nature and intensity of the differences between samples. Affective tests are concerned with the measure of preference (or acceptance) or the measure to determine the relative preference or opinion of the panelists towards a product. In sensory analysis programmes, testing for sameness is referred to as similarity or sameness testing predominantly carried out in quality control programmes whiles testing to find a difference is referred to as discriminative or difference testing concerned mainly with quality maintenance, cost reduction, selection of new sources of supply, effect of a new packaging material on product storage stability (Poste *et al.*, 1991). Examples of types of discriminative tests include triangle test, duo-trio test, two-out-of-five test, paired comparison test and ranking test.

2.17.2 Triangle Test

In a triangle test, the panelists receive three coded samples and are told that two of the samples are the same and one is different. They are asked to identify the odd sample. This method is useful in quality control work to determine if samples from different production lots are different. It is also used to determine if ingredient substitution or some other change in manufacturing results in a detectable difference in the product.

Usually, the samples differ only in the variable being studied thus the test is limited to products that are homogeneous. There are six possible ways in which the three samples in a triangle test can be presented (ABB, BBA, AAB, BAB, ABA, and BAA) and thus the order of evaluation of each sample by the panelists is specified with code numbers on the score sheet. In most cases, each sample is used as the duplicate for half the tests and as the different samples for the other half. The results of a triangle test indicate whether or not a detectable difference exists between two samples. However, higher levels of significance do not indicate that the difference is greater or in a certain direction but that there is a greater probability of a real difference. Analysis of the results of triangle tests is based on comparing the number of correct identifications actually received with the number one would expect to get by chance alone if there were no difference between the samples. One would expect the odd one to be selected by chance one-third of the time (Poste *et al.*, 1991).

2.17.3 Statistical Errors of Discriminative Tests

Following the computation of the relevant test statistic of a discriminative sensory analysis, one either accepts or rejects the null hypothesis of the test. Associated with the decision to accept or reject the null hypothesis, that is 'there are no differences between the samples' are two types of errors. A type I error occurs when the null hypothesis is rejected when it is true; that is, saying there is a difference when in fact there is none. A type II error occurs when the null hypothesis is accepted when in fact it is false; in other words, saying there is no difference when there really is one. The probability of making a Type I error is the level of significance (α). This type of error is associated with difference testing in quality maintenance, cost reduction, selection of new sources of supply, and storage stability studies. Usually the level of significance is set at 0.05(5%) or 0.01(1%). The 0.05 level of significance means there is a 1 chance out of 20 of saying there is a difference when there is no difference. A result is considered to be significant if the probability (P) is 0.05 or less. The probability of making a Type II error is β usually associated with sameness or similarity testing in quality control programmes where new products are tested against standard products to ensure that they do not differ. A Type II error can be minimized by using acute, reliable panelists and by increasing the sample size (Poste *et al.*, 1991).

Table 2.4: Summary of eventualities for error risks in Hypothesis Testing

Outcome of experiment dictates	State of the Population	
	H_0 is actually true	H_0 is actually false
Retain H_0	Correct decision: Probability of retaining true H_0 is 1-α	Type II Error: Probability of retaining false H_0 is β
Reject H_0	Type I Error: Probability of rejecting true H_0 is α	Correct decision: Probability of rejecting false H_0 (power) is 1-β

Source: Opoku, J.Y., 2006

2.17.4 Efficiency of Sensory Panelists

A sensory panel is the analytical instrument in sensory analysis. The objectivity, reproducibility and precision of judgment of the panelists are of significant value in any reliable sensory evaluation programme. The selection criteria include the health, interest, availability, punctuality and verbal skills of persons within reach of the sensory programme (Poste *et al.*, 1991). Training tends to enhance the sensitivity and memory of the panelists to provide precise, consistent and standardized sensory measurements that can be reproduced. The interest of subjects can be sustained by motivating them with incentives such as gifts, appreciation notices and updates of the outcome of their participation in a sensory programme (Stone and Sidel, 1993).

2.17.5 Sample Preparation and Serving in Sensory Analysis

The preparation and serving of samples to subjects have an influence on the results that one would obtain from a sensory evaluation programme. For beverages, the usual serving temperature known of the product or product category is recommended to ensure such uniformity for all samples (Poste *et al.*, 1991). For instance, orange drink would be best served chilled. Some panelists may use the temperature difference of samples to make judgments instead of the sensory property under study. Therefore the preparation and serving method as much as possible must not mask, add to or alter the basic sensory characteristics of the product (Stone and Sidel, 1993). Other important considerations in preparation and serving of product samples include dilution, product carriers, product containers, amount or size of sample, number of samples per subject, reference samples, coding, order of presentation, rinsing (mouth and serving containers), time of day and information about samples. These should be done properly to minimize or avoid costly errors. Late morning and mid afternoon are generally the best times for sensory testing. Exclusion of persons directly involved in the experiment from the panel is necessary. Many researchers prefer taste-neutral water at room temperature for oral rinsing but when fatty foods are being tested, warm water, warm tea, lemon water, or a slice of apple or Japanese pear is a more effective cleansing agent. Unsalted crackers, celery, and bread have all been used for removing residual flavours from the mouth (Poste *et al.*, 1991).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Design of Experiment

The study was in two parts, the first part involved a survey using a structured questionnaire and the second part involved laboratory work in assessing the product and package quality of an orange drink product. For the survey, the opinions of stakeholders were collated on the assertion that 'the standard or quality of packaging of most food and beverage products made in Ghana is poor' at a 95% confidence level. The questionnaires for the survey were essentially tailored towards assessing the perception of stakeholders of industrially processed and packaged food and beverage products made in Ghana. The stakeholders included consumers, converters (manufacturers of packaging material or products), users of packaging products (food manufacturers or processors) and other relevant corporate respondents (general). Null hypothesis (Ho): Respondents disagree with the assertion.

Alternative hypothesis (H_A): Respondents agree with the assertion

3.2 Sample Population

The sample population used for the survey was the student population of the campus of the Kwame Nkrumah University of Science and Technology(KNUST), Kumasi which was estimated to be 19,854 (Anon., 2005). KNUST was used as the defined test community (miniature Ghana) because it has a fairly similar and cosmopolitan demography as that of the general literate population of Ghana and it typifies the youthful adult population of Ghana (GLSS IV, 2000). The sampling frame for the survey consisted of four sampling units namely, consumers, converters, manufacturers (users) and other relevant corporate institutions.

3.3 Sampling Method

The sampling method employed in the survey was a combination of probability and non-probability techniques in selecting relevant respondents of the sample frame. The probability method used is random sampling whiles the non-probability sampling techniques included convenience and quota sampling (Papadopoulos *et al.*, 2004).

3.4 Questionnaire Administration

3.4.1 Pre-testing

Pre-testing of the questionnaires was carried out on KNUST campus to fine-tune the format, wording, length and objectives of the questionnaires using 30 of the draft questionnaires. They were analyzed and the necessary modifications effected prior to its use.

3.4.2 Sample Size and Questionnaire Editing

Over 400 of the final questionnaires (Questionnaire A1) were issued by hand to respondents in the consumers' category on KNUST campus and in Accra. The non-probability approach to selecting relevant respondents (convenience and quota sampling) was used to select 10 corporate respondents each for the rest of the three sample units of the sample frame. These units were food packaging-related corporate respondents (general), users and converters. Questionnaires A2, A3 and A4 were used to conduct the surveys for these categories respectively (Appendix 6). The questionnaires recovered were edited with checks for omissions, incomplete or otherwise unusable responses, illegibility and inconsistencies.

3.5 Development of Alternative Packaging Design

3.5.1 Comparative Analysis of Packaging Options for Food and Beverage Products

A comparative appraisal of some commonly used primary food packaging designs for food and beverage products was undertaken. Enquiries and consultations were made with some converters and marketing companies of food packaging products in Ghana by the researcher (Appendix 2e). The main criteria used were the relative fixed and recurrent costs involved in using a given packaging design/technology. These included affordability, availability and accessibility of the packaging technology and general functional attributes of the different packages. The fixed costs included cost of machinery and installation whiles the variable costs included cost of packaging material (container), printing cost, personnel cost, maintenance cost, power consumption cost, etc. In collaboration with the management of Fruits and Flavours Ltd and based on the findings of the appraisal, a labeled translucent High Density Polyethylene (HDPE) bottle was chosen and developed as the alternative packaging design for Fresh Taste.

3.5.2 Design of Labels

A professional graphic designer was engaged to propose different designs for printing onto a water-proof paper. The design was premised on the need to communicate the freshness and naturalness of the orange drink product to consumers with marked visual appeal. Various full colour graphic designs for the Fresh Taste label were created using Photoshop Version 6 (2005) graphics software and one was selected based on assessment by five volunteers (arts students from KNUST) in collaboration with the management of Fruit and Flavours Ltd. The artistic design was printed in full colour unto 135GSM art paper to produce 2,000 labels at Combert Impressions Limited, Accra.

3.6 Production of Fresh Taste

Fresh Taste was produced at the factory site at Asebu in the Central Region. The process flow chart for production is shown in Figure 3.1.

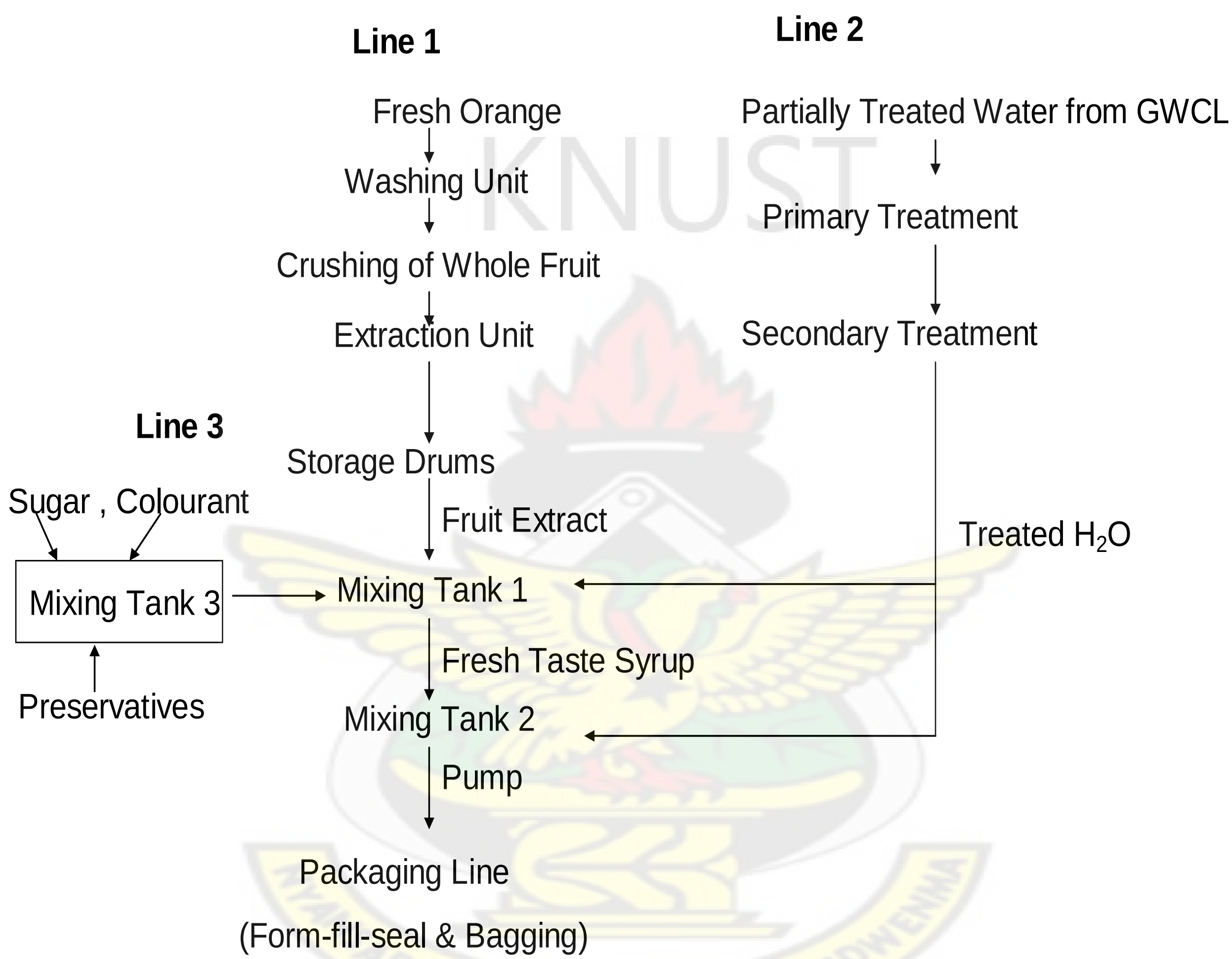

Figure 3.1: Flow Chart of Fresh Taste Production

Figure 3.1 summarizes the production of Fresh Taste. Three main lines of activities are involved. Line1 involves the receipt of fresh whole orange fruits at the receiving bay which are then washed in three phases. The water in the washing basins at the last phase is required to meet the standards of potable water before the fruits are conveyed to the next unit operation for further processing. The whole fruits are crushed in a huge crushing tank after which extraction of the orange juice is done by removing the debris by filtration under pressure (orange rind and fibre) at 7 tonnes per hour. The extract is then transferred into Mixing Tank I for further processing or storage in plastic or stainless steel drums for a maximum of three days until needed. Line 2 involves the treatment of water which is usually from two main sources, the public water supply system (Ghana Water Company Limited) and a borehole as a back up source of water.

Figure 3.2: Fresh Taste in existing package (HDPE sachets and bags)

The regular source of water (GWCL) which comes as partially treated is primarily subjected to coagulation and sterilization using Calcium Hydroxide and Chlorine respectively. The secondary treatment by filtration is done through a series of sand, carbon and cartridge units. Line 3 is a single stage unit operation involving the mixing of the sweetener (sugar), colourant and preservatives. Lines 1, 2 and 3 converge at Mixing Tank I to obtain Fresh

Taste Syrup (Brix 50-56%). The syrup is further diluted to a Brix level between 5-10% in Mixing Tank II. The product is then finally pumped into the form-fill-seal packaging machine line for unitization into 150ml and 350ml sachets and manually bagged as 50 and 25 sachets per bag respectively.

3.7 Packaging of Fresh Taste

500ml translucent HDPE bottles (plus white plastic caps/closures) were obtained from Polyproducts Ghana Ltd, Accra and were labeled with the full colour 135GSM art paper labels using a water-tolerant adhesive.

Figure 3.3: Form-fill seal packaging unit of Fresh Taste production

The newly designed package was used for the bottling of Fresh Taste drink semi-manually without pasteurization at Fruits and Flavours Ltd, Asebu in the Central Region and packaged into cardboard boxes (24.13 x 22.86 x 5.56cm) of 24 bottles each. 350ml and 150ml packs of 25 and 50 sachets of unpasteurized Fresh Taste respectively were thermally-sealed using an automatic form-fill-seal machine and packaged in HDPE bags at Fruits and Flavours Ltd, Asebu.

3.8 Shelf Life Study of Fresh Taste in the Two Packaging Designs

The microbial load, sensory or organoleptic properties and total titratable acidity of Fresh Taste were used as measurable indicators for the evaluation of the shelf life of unpasteurized Fresh Taste in the two different packaging materials for a period of 7 weeks. Fresh Taste packaged in High Density Polyethylene (HDPE) sachets and translucent HDPE bottles were kept under three storage and/or distribution conditions namely refrigeration (2-5°C), room (21-32°C) and outdoor/open market temperatures (>28°C). The refrigeration condition was set in an LG Express Cool Refrigerator (Model GR 242 MF, Germany) whiles the warehouse of a key distributor of Fresh Taste in Kumasi (Ayeduase) provided the room condition for the storage of the Fresh Taste samples. The roof terrace of the key distributor's warehouse served as the outdoor/open market storage condition.

3.9 Microbial Load Determination

Based on the Ghana Standards Board general specifications for Fruit Juices (non-alcoholic beverages), microbiological analysis that were carried out included Aerobic Plate Count (APC), Staphylococcus aureus, Coliforms, Yeast and Moulds. Yeast and Coliform counts were used as the microbial load indicators for the shelf life study after the preliminary microbial load determination at week zero. These acidophilic microbes (lactic acid bacteria and yeast) were analyzed because they have been shown to be the major contaminants in citrus juices (Ros-Chumillas *et al.*, 2007).

3.9.1 Sample Preparation

100 glass test tubes were each filled with 10ml of distilled water and plugged with cotton wool. The test tubes were placed in a metal basket and sterilized by autoclaving at 121°C for 15 minutes. In preparing the serial dilutions of the Fresh Taste samples, each test tube containing 9ml of sterilized distilled water was unplugged, flamed with a Bunsen burner and 1ml of the Fresh Taste drink sample was aseptically transferred into it using a micropipette. The sample was thoroughly mixed to obtain a dilution of 10^{-1}. This procedure was repeated with each dilution as stock from which decimal dilutions of 10^{-2} up to 10^{-10} were prepared. This procedure was used for the preparation of serial dilutions of Fresh Taste for the different media (and broth) in the enumeration of Staphylococcus aureus, Aerobic Plate Count, Yeast, Mould and Coliform load in the Fresh Taste samples (Atlas *et al.*, 1995).

3.9.2 Inoculation of Media with Sample

The pour plate technique was used for the inoculation. Using sterile Petri dishes, 1ml of Fresh Taste sample (of known dilution) and suitable amounts (about 15ml) of molten media (40-45°C) was poured and mixed by swirling. This technique was used for all the microbial determinations using sterile distilled water as control (Atlas *et al.*, 1995).

3.9.3 Total Aerobic Plate Count (APC)

Plate Count Agar (PCA) was used as the basal medium. The PCA (2%) was prepared based on the manufacturer's guidelines. After inoculation, the Petri dishes were incubated for 18-24 hours at 37°C in a Gallenkamp Incubator, (Model 1H-150, UK). The colonies formed on the media were counted using a Stuart Scientific Colony Counter (Serial # 7354, UK). The total aerobic microbial load was expressed as the colony forming units per ml (Atlas *et al.*, 1995).

3.9.4 Staphylococcus aureus Determination

The selective media, Lab Lemco was used as the media for the determination of S. aureus (Atlas *et al.*, 1995). The media consisted of 3g Lab Lemco, 18g Agar agar, 10g mannitol, 1.5g NaCl, and 0.5 g Phenol red in 1000ml of distilled water. The media was prepared based on manufacturer's guidelines. After inoculation, the Petri dishes were incubated for 18-24 hours at 37°C in a Gallenkamp incubator (Model 1H-150, UK). S. aureus presence after incubation was expressed as positive by a colour change from yellow in the acidic medium to red under alkaline condition and vice versa (Atlas *et al.*, 1995).

3.9.5 Yeast Load Determination

Yeast extract agar was used as the media for the enumeration of the yeast load. After inoculation, the Petri dishes were incubated for 18-24 hours at 37°C in a Gallenkamp incubator (Model 1H-150, UK). The total yeast load after incubation was expressed as CFU/ml after counting the colonies using the colony counter (Atlas *et al.*, 1995).

3.9.6 Mould Load Determination

Cassava Dextrose Agar (CDA) was used as the media for enumeration of the mould load. The media was prepared by gently boiling 100g of chopped fresh cassava pieces into 500ml of distilled water for about 30 minutes. The preparation was then filtered using a sterile cheese cloth and cotton wool. The volume of the filtrate was then made up to 1000ml using sterile distilled water. 20g glucose and 15g Agar agar were weighed and dispersed into the 1000ml cassava infusion and mixed thoroughly. The media was then sterilized by autoclaving and used for mould determination. After inoculation, the dishes were incubated for 18-24 hours at 37°C. The total mould load after incubation was expressed as CFU/ml (Atlas *et al.*, 1995).

3.9.7 Coliform Load Determination

Total coliform load was determined using the Most Probable Number (MPN) method (Atlas et al., 1995). Mackonkey broth was used as the media for the determination. The broth was prepared based on the manufacturer's guidelines. Serial dilutions were prepared from 10^{0}, 10^{-1}, up to 10^{-10} in triplicates. 1ml of sample of known dilution was then inoculated into the dilutions. These were then incubated at 37°C for 18-24 hours. The test tubes were observed for colour change from violet to yellow. The concentration of Coliforms in the original stock of Fresh Taste was determined using the Most Probable Number (MPN) estimation rules and a statistical probability table (Atlas et al., 1995). The results were an estimate of the mean density of coliforms in the sample and were reported as MPN.

3.10 Determination of Titratable Acidity (TTA) %

10ml of Fresh Taste samples were measured in triplicates into 250ml conical flasks using a pipette. 2-3 drops of phenolphthalein indicator were added to each sample and titrated using standardized 0.1N NaOH solution. The endpoints of the titrations were noted when the colour of the sample solution changed to pink. The TTA% was calculated as shown in Appendix 1.

3.11 Sensory Evaluation

Two indicative sensory tests namely triangle test and preference test (9-Point Hedonic) were carried out on unpasteurized Fresh Taste packaged in 500ml HDPE bottles and 350ml/150ml

HDPE sachets. A serene, well aerated laboratory was used for the preparation and serving of samples to the panelists. Panelists were given biscuits and some of the Fresh Taste drinks as incentives for their continued participation.

3.11.1 Triangle Test Procedure

50 adults (18 years plus) mainly laboratory technicians, labourers and students were conveniently invited to avail themselves for orientation and training. The voluntary trainees were served with chilled, fresh samples of Fresh Taste and their perceptions were discussed in line with the sensory parameters generated for the test. The sensory parameters of Fresh Taste generated from the training were flavour (aroma and taste) and texture (turbidity or mouth-feel). The triangle tests were carried out over a period of seven (7) weeks. Each panelist was served with 3 chilled samples of Fresh Taste. Panelists were instructed to identify two of the three samples that they perceived to be identical concurrently in terms of flavour (taste and aroma) and texture (turbidity or mouth-feel). Results of panelists who could not detect the true differences in flavour and texture concurrently were rejected. The test samples were assigned number codes to mask their true identity. Each test sample was served in duplicates for half of the tests and as the different sample for the other half to block any possible sources of variability due to serving format. The sensory evaluation was carried out with comparison between freshly produced Fresh Taste and samples of the unpasteurized Fresh Taste packaged in HDPE bottles and sachets and kept under three non-isothermal storage conditions namely refrigeration temperature (2-5°C), room temperature (25-32°C) and outdoor/open market temperature (≥ 28°C). The observations made by the panelists were indicated on the sensory evaluation form B3 administered during the test (Appendix 6). A critical value (Probability, P) = 0.05 was used for the statistical evaluation where Probability

(P) of correct judgment <0.05 meant product was unwholesome and Probability (P) of correct judgment ≥ 0.05 meant product was wholesome. The probability of correct judgment was read from a statistical chart (Roessler *et al.*, 1978). Product batches where differences were detected were inferred as unwholesome based on the probability of correct judgment. The consistency of Fresh Taste produced for the triangle test was evaluated. The pH and sugar content (%) of fresh samples of Fresh Taste produced weekly were used as indicators of the consistency or uniformity of production quality (repeatability effect). This was to serve as control or standard for the triangle test. The pH of freshly produced Fresh Taste packaged in the HDPE bottles and the HDPE sachets were determined in triplicates using a digital pH meter (WTW, Multi Cal®, Germany) at room temperature. The sugar content (Brix) of freshly produced Fresh Taste packaged in the HDPE bottles and the HDPE sachets were determined in triplicates using a refractometer (PE Nelson Refractometer, Model 1022).

3.11.2 Complementary Preference Test (9-Point Hedonic)

The preference levels of 75 sensory panelists for Fresh Taste and another locally packaged (Tetrapak) orange drink product (Kalypo) on the local market were compared using a 9-Point hedonic scale where 1=like extremely; 5=neither like nor dislike and 9=dislike extremely. The responses of the panelists were recorded on the sensory evaluation form B1 administered during the test (Appendix 6).

3.12 Appraisal of New Packaging Design

3.12.1 Laboratory Acceptance Panel Assessment of the Two Packaging Designs

The effectiveness and efficiency of the communication function of the newly designed package of Fresh Taste was evaluated by 100 panelists using a questionnaire. The participants were made up of randomly selected consumers of packaged orange drink products. The laboratory acceptance panel was presented with an exhibit of the two primary packaging designs. The panel visually inspected and indicated their preferences on Questionnaire Form C1.

3.12.2 Appraisal of Fresh Taste Cost in the New Packaging Design

The price of Fresh Taste packaged in the labelled translucent bottles was collaboratively determined with the Management of Fruit and Flavours Limited, Asebu (C/R). A balanced interplay of the other elements of the marketing mix of Fresh Taste was used to arrive at the ex-factory price. These include the product (clarified single-strength natural orange drink), distribution (network of privately owned regional depots in Ghana) and promotion (adverts via TV and illustrated posters) as observed over the period since inception of its production in the year 2000. An appraisal of the ex-factory price was carried out by 100 panelists. The marketing environment of packaged refresher drink products on the Ghanaian market was taken into consideration in pricing the new product. The marketing environmental factors considered include:

- ✓ competition (influx of artificially flavoured non-alcoholic beverages)
- ✓ state of economy (purchasing power of consumers in the target market)
- ✓ natural environmental factors (dry season being the peak period of consumption of refresher drink products)
- ✓ regulatory and technological elements (insistence on adherence to food quality and safety standards by FDB and GSB especially beverage manufacturers)
- ✓ social elements (increasing consumer right awareness, changing habits towards consumption of naturally formulated beverages).

The general formula used for the pricing is illustrated in Appendix 1(a).

3.13 Statistical Analysis

The data obtained from the survey questionnaires (different categories) and the sensory test questionnaires were analyzed using SPSS Version 11(2005) statistical package. The Chi square test of independence was used for the analysis of the hypothesis. Data obtained from the comparison between the package designs and evaluation of the effectiveness of the communication function of the new packaging design were analyzed for differences of means at $P<0.05$ by ANOVA and level of differences by Least Significant Difference of means (LSD) (GENSTAT 5, Release 3.2). Some data were illustrated graphically where necessary using Microsoft Excel-Microsoft Office 2003 and SPSS Version 11(2005).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Overview of Respondents of the Survey

Three hundred and sixty-eight (368) of the questionnaires issued to obtain an overview of consumers' opinion on the packaging of food and beverage products made in Ghana (MIG) were recovered. The statistical summary of the demographic parameters of the respondents (consumers) are presented in Table 2.1a (Appendix 2a) whiles the corporate respondents are listed in Tables 2.1a, b and c (Appendix 2b). The respondents (consumers) were fairly distributed across the various age groups, genders, economic classes, marital status, educational backgrounds and occupations but predominantly consisted of 18-25 year olds, males, middle income earners, singles and tertiary level students respectively (Table 2.1a).

4.2 Appraisal of Stakeholders' Perception of Packaging of MIG Products

Generally, it could be inferred from the statistical analysis of the responses of the stakeholders interviewed that, the quality or standard of packaging of most food and beverage products made in Ghana (MIG) is not perceived as poor as summarized in Table2.1b (Appendix 2a). The statistically computed value of chi square (X_{cal}) was less than the critical value ($0.523 < 7.82$ at P=0.05 and d_f =3), thus the null hypothesis was accepted. This contradicts the popular assertion that the quality of packaging of most food and beverage products made in Ghana is poor. There are however qualitative indicators such as the impressive graphic appeal of the packages of foreign products on the local market which seems to make obvious the level of underdevelopment of the packaging industry in Ghana when foreign products are compared with MIG products.

4.2.1 Consumers' Impressions of Packaging of Food and Beverage Products (MIG)

First impressions with regards to packaging and utility of a given product are essential for initial and sustained consumer preference (Dalzell, 1994). This phenomenon was observed in the response of 95% of the food and beverage (F&B) consumers interviewed on whether their choice of a food and beverage product was influenced by packaging. The results shown in Fig 4.1 indicates that they were influenced sometimes (62%), most times (14%) and always (19%). This underscores the importance of packaging as an integral part of new food product development in terms of marketability as reported by Baker *et al.* (1988).

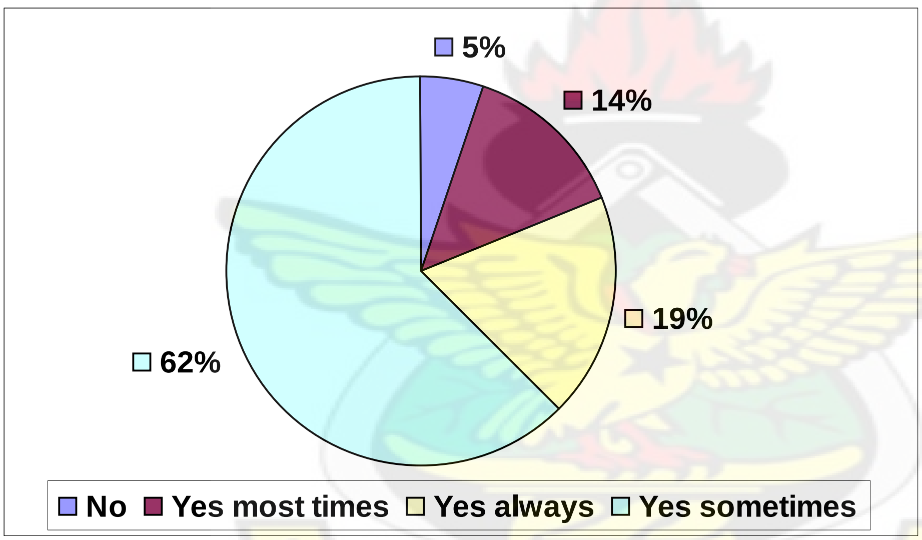

Figure 4.1: Influence of packaging on choice of food and beverage product

Figure 4.2 indicates the contentment of consumers with regards to the standard or quality of packaging of locally made food and beverage products. The assertion therefore that packaging of most food and beverage products made in Ghana (MIG) is poor is one not held by most of the consumers interviewed. Nonetheless, the assertion that poor packaging is the weakest link in the value chain of food and agricultural products especially in developing countries is a popular maxim in Ghana (Anon., 2004). This is particularly rife of locally processed food and beverage products as asserted by the Minister of Food and Agriculture in November, 2003 during the launching of the Institute of Packaging Ghana (IOPG). The minister noted that, poor packaging is the reason why excellent made-in-Ghana (MIG) products are unable to compete on the local market and worst still on the international market in the mix of globalization (Anon., 2004). Thus, 81% of the consumers interviewed rated the packaging of most food and beverage products made in Ghana as comparable to the foreign ones whiles 18% rated it as inferior (Fig 4.4). Figures 4.2, 4.4 and 4.5 also suggest that, though the quality of packaging of most food and beverage (F&B) products made in Ghana is reasonably satisfactory in the opinion of most consumers (82%), it is disadvantaged in terms of marketability compared to foreign products on the local market.

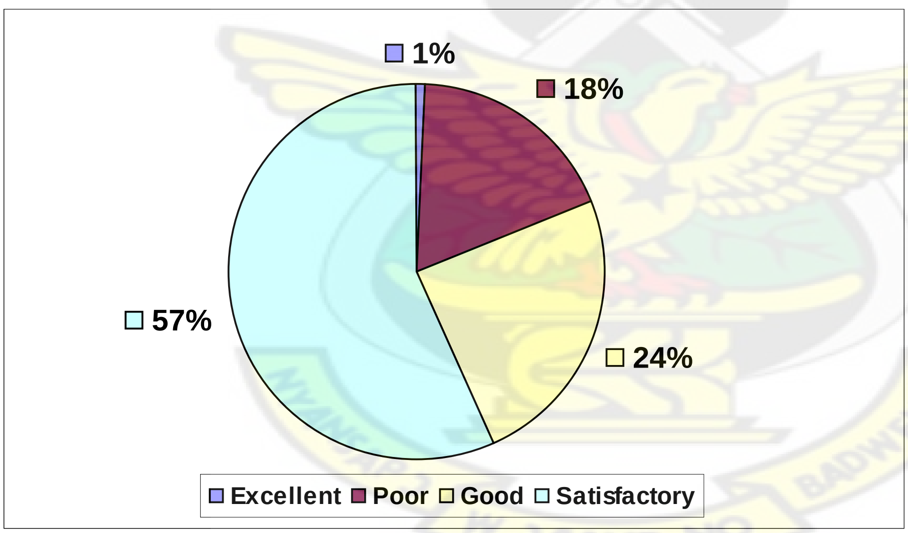

Fig. 4.2: Standard/quality of packaging of most food and beverage products (MIG)

Notwithstanding that some made-in-Ghana products may be doing well on the local market, foreign food and beverage products seem to have an edge over the local ones because 88% of the respondents intimated their preference for foreign food and beverage products to locally made ones (Fig 4.5). Various reasons have been alluded to the tendency of Ghanaian consumers to patronize foreign food and beverage products over locally made ones.

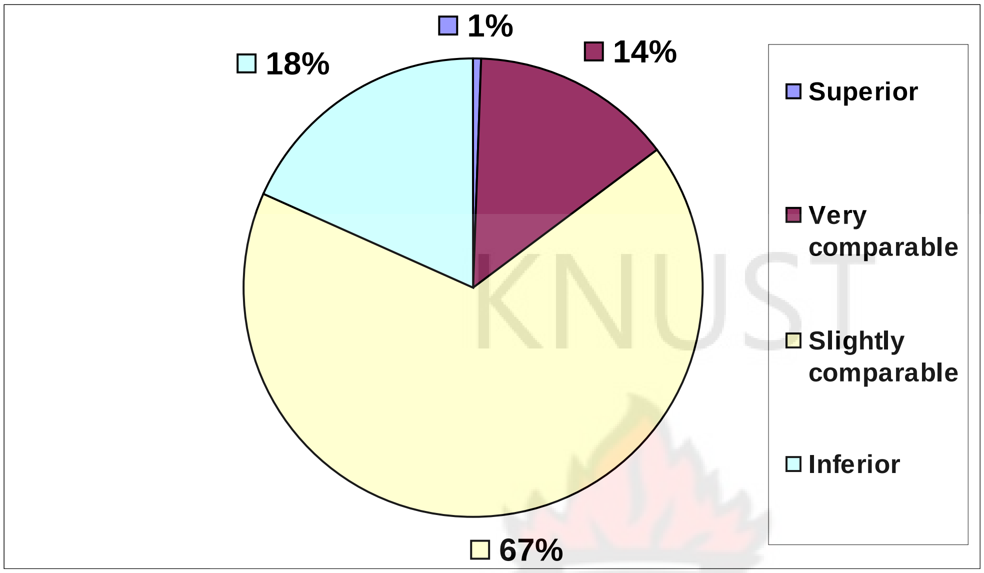

Figure 4.3: Rating of made-in-Ghana (MIG) food and beverage product packaging against foreign ones

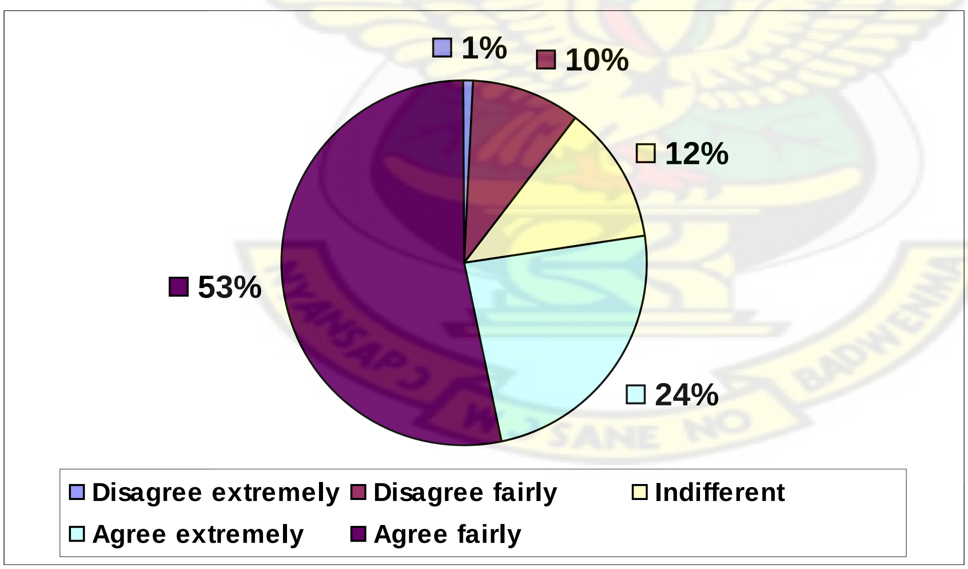

Figure 4.4: Agreement with the assertion that 'most food and beverage products made in Ghana are less competitive on the local market compared with foreign ones'

Some consumers perceived foreign food products to be of better quality (45%), better packaging (35%) and were sold at more competitive prices (12%) than MIG products (Fig. 4.6). This is quite paradoxical considering the maxim that consumer demands are the driving force behind innovation from which designers or manufacturers find their muse to satisfy the unlimited wants of consumers (Anon., 2008; Budway, 2005). It was thus expected that consumers interviewed would rather express a significant level of discontentment with the quality or standard of packaging of most food and beverage products made-in-Ghana. This is especially so where 88% of the respondents indicated their preference for foreign food and beverage products over locally made ones premised on packaging, product quality and competitiveness. Ofosu-Okyere *et al.* (1997) however reported that, the degree and extent to which packaging is carried out varies from nation to nation depending on the level of development, the level of industrialization and the culture of the people. Ghana is a developing country and rightly so the level of industrialization is commensurate with this status. The contentment of consumers in Ghana with the standard or quality of packaging of most food and beverage products made-in Ghana could therefore be interpreted as an expression of a Ghanaian cultural instinct or tendency towards food and beverage packaging. This tendency is one that minimally appreciates innovation in modern packaging functionality and design probably as a result of limited exposure of Ghanaian consumers to functional packaging designs in vogue, low consumer right awareness and low purchasing power.

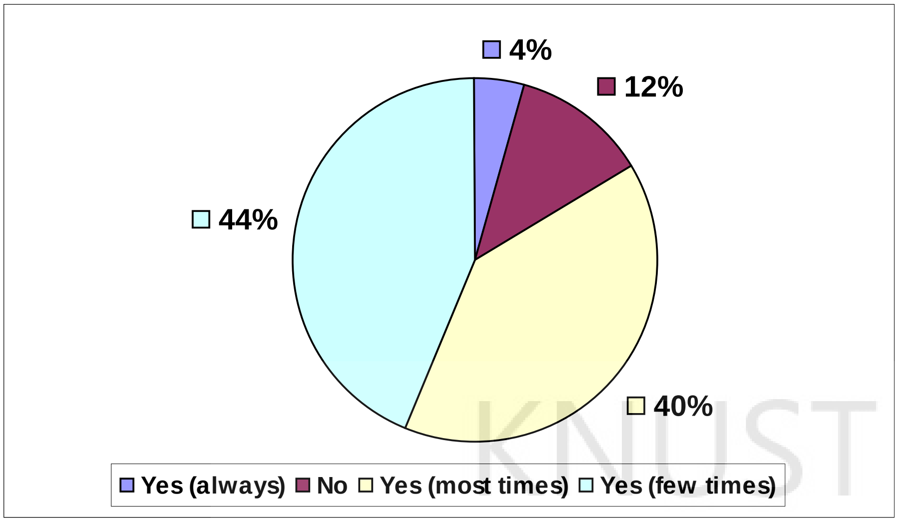

Figure 4.5: Preference of foreign food and beverage products over MIG products

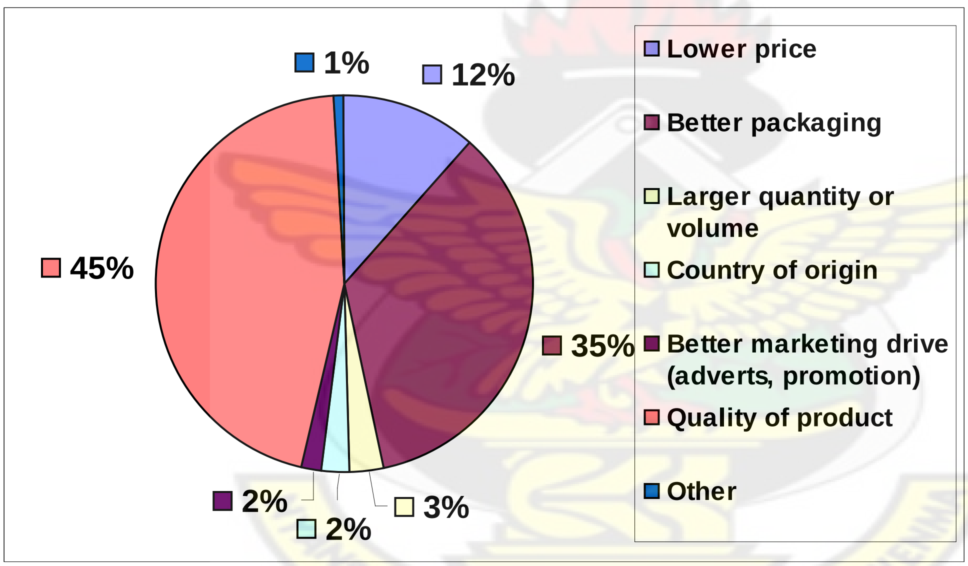

Figure 4.6: Reasons for preference of foreign food and beverage products over MIG products

4.2.2 Impressions of Converters, Manufacturers and Other Corporate Respondents

The corporate respondents reached during the survey are listed in Table 2.17 (Appendix 2b). Being on the supply side of the value chain and thus the ones directly responsible for the quality or standard of packaging of food and beverage products made in Ghana, a favourable opinion was expected to be given by the packaging converters (producers of packaging products) and users (food manufacturers or processors). Most of the packaging converters interviewed (83.3%) rated the packaging of most food and beverage products made in Ghana as satisfactory whiles the rest (16.7%) rated it as good (Table 4.1).

Table 4.1: Perception on the quality of packaging of most food and beverage products made in Ghana (Converters)

Perception of packaging converters	No. of Respondents	Percent
Good	1	16.7
Satisfactory	5	83.3
Poor/Unsatisfactory	0	0.0
Total	6	100.0

Table 4.2: Perception on the standard or quality of packaging of most food and beverage products made in Ghana (Users)

Perception of packaging users or food processors	No. of Respondents	Percent
Good	1	16.7
Satisfactory	4	66.7
Poor	1	16.7
Total	6	100.0

Table 4.3: Perception on the standard or quality of packaging of most food and beverage products made in Ghana (Other Corporate respondents)

Perception of other corporate respondents	No. of Respondents	Percent
Satisfactory	5	71.4
Poor	2	28.6
Total	7	100.0

66.7% of the food manufacturers interviewed (users of packaging materials or products) rated the quality of packaging of most food and beverage products made in Ghana as satisfactory whiles 16.7% rated it as good or poor (Table 4.2). 71.4% of the other corporate respondents interviewed rated the standard of packaging of most food and beverage products made in Ghana as satisfactory and the rest (28.6%) rated it as poor (Table 4.3). 83.3% of the Users (manufacturers of food and beverage products) interviewed rated the packaging of most food and beverage products made in Ghana as satisfactory. Generally, all the corporate respondents asserted that the quality of packaging of most food and beverage products made-in-Ghana was satisfactory. This is in agreement with the perception held by most of the consumers of food and beverage products made in Ghana from the interviews.

4.3 Comparison amongst packaging design options for beverages.

Table 4.4: Summary of some primary food packaging design options for beverages

Packaging Design	Packaging Material	Relative Affordability (Sachet *)	Common Attributes	Common Example of Usage	Available in Ghana?
Tetrapak®	Laminated paper	******	Convenient, Handy, Strong Integrity	Kalypo®	Yes
Labeled Bottle	HDPE	***	Convenient, Re-useable, Handy, Easy packing	Tampico®	Yes
Labeled Cups	HDPE	***	Handy, Cute	Fan Yogo®	Yes
Doy Pack	Laminates	*****	Appealing, Not handy	Nourisher®	No
Flexible Tube/Sachet	HDPE/LDPE	***	Easy to unitize, Light weight	Poki®	Yes

Average material, machinery, operational and maintenance cost rated by asterisk (*) relative to using sachet (Each asterisk represents a significant cost component)

A comparison of some commonly used primary food packaging designs for beverages is summarized in Table 4.4. These were based on information obtained from enquiries and consultations with some packaging converters and marketing companies of food packaging products in Ghana (Appendix 2e). It was realized that most of the packages being used by the small and medium scale beverage processors interviewed during the survey of food packaging design options in Ghana were made of High Density Polyethylene (HDPE) and PP (Polypropylene) plastics. 64.4% of the respondents in the survey indicated their preference for bottles made from plastics. 27.7% preferred plastic sachets whiles the rest preferred other designs such as plastic cups and flexible tubes (Table 4.5). Most of the processors interviewed adjudged the cost of the other packaging design options to be too high with regards to the willingness of the Ghanaian consumer to purchase products at the realistic retail price of such designs. The economy of scale required to make such packaging designs cost-effective is high since the demand by the food and beverage industry in Ghana for such modern but pricey packaging designs is not high enough (Mante, 2005). The stranglehold of plastic sachets and bottles on the Ghanaian market is attributable to the affordability of the ultimate pre-packaged product to the consumer whiles being less costly and more convenient (light weight for transport) to the producer compared to the other packaging technologies or designs. This trend complements the advocacy of Boga-N'guessan (2005) for microdose packaging technology or concept which is asserted to be the most economical, practical and hygienic alternative to bulk packaging in developing countries. The micro-dose concept is premised on putting the right quantity at the right price within reach of the poorest segments of society. Sachets and bottles are usually apportioned into between 150-500ml packs in Ghana. This is quite contrary to the trend in Europe where weight, environmental impact and barrier properties of the packaging material tend to be the most influential factors in the choice of packaging technology (Dalzell, 1994). Some of the other packaging design options noted on the market were the Doy Pack (laminated pouch), Tetra Pak (liquid carton), collapsible cups and flexible tubes. Though these designs are not popular in the wider food and beverage consumer market in Ghana, they have more distinct differential attributes making such brands unique and fairly outstanding. Soares and Hotchkiss (1999) suggested that when considering a packaging material for orange juice packaging, it would be appropriate to select the material that better matches ones quality objectives, shelf life, storage temperature and cost of the product even though in most cases juice product manufacturers do not exactly know the particular behaviour of the commercial packaging materials.

In collaboration with the management of Fruits and Flavours Limited, a water-resistant 135GSM art paper-labeled HDPE plastic bottle was used for the production of Fresh Taste as an alternative package in addition to the form-fill-seal HDPE sachet as shown in Figures 4.7, 4.8, 4.9 and 4.10. This was mainly premised on cost and reliability of supply of the packaging material to the producer on one hand and affordability to consumers on the other cognizant of the economic worth or utility of the product.

Table 4.5: Preferred packaging design made from plastics

Packaging Design Preferred	No. of Respondents	Percentage
Sachets	**102**	**27.7**
Bottle	**237**	**64.4**
Cup	**18**	**4.9**
Flexible tube	**9**	**2.4**
Other	**1**	**0.3**
Total	**368**	**100.0**

Fig. 4.7: Graphic design of new Fresh Taste label (HDPE Bottle)

Fig. 4.8: Secondary package of new package design (card box)

Fig. 4.9: Twist-lock crowns of HDPE Bottles

Fig. 4.10: Labeled HDPE bottles of Fresh Taste

4.4 Shelf life Evaluation by Sensory Analysis (Triangle Test)

The sensory properties of the orange drink product (Fresh Taste) were monitored by between 20-40 sensory panelists for a period of 7 weeks. The mean pH for the 7 weekly batches of production was 4.07 compared to the standard of 4.0 at 25°C. The mean sugar content obtained was 5.08% compared to the standard of 5.0%. Significant differences ($p<0.05$) were observed with regards to pH and sugar content between the fresh batches of each Fresh Taste production (control) over the 7-week period. Observations made during the triangle tests were therefore attributable to other factors in addition to the heterogeneity in the attributes of the control samples. Table 4.6 is a summary of the triangle test results conducted to evaluate the performance of the two packaging designs (HDPE sachet and HDPE labeled bottle). The test product was interpreted as having become unwholesome when probability of correct judgment by the sensory panelists was less than 0.05. No detectable differences were observed in the sensory attributes (Flavour and Texture) of the Fresh Taste samples kept under the different storage conditions in the two packaging designs before the fourth week (Fellers, 1988). At week 4 however, changes in flavour (taste and aroma) and texture (mouthfeel) were observed by the sensory panelists in all the samples except the bottled samples under fridge and room storage conditions as well as the sachet samples under fridge condition probably due to off-flavour generation or flavour scalping by the packaging material (Askar, 1999; Nielsen, 1994; Roig *et al.*, 1996).

Table 4.6: Probability of Correct Judgment of Changes in Samples of Fresh Taste

Packaging Design/ Storage Condition	Probability of Correct Judgement						
	Week 0	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Bottle(Fridge)	0.778	0.940	0.240	0.001	0.293	0.996	0.999
Sachet(Fridge)	0.630	0.940	0.399	0.231	0.422	0.468	0.376
Bottle(Room)	0.462	0.191	0.581	0.083	0.293	0.213	0.087
Sachet(Room)	0.304	0.191	0.125	0.001	0.001	0.001	ND*
Bottle(Outdoor)	0.092	0.092	0.002	0.001	ND*	ND*	ND*
Sachet(Outdoor)	0.178	0.339	0.002	ND*	ND*	ND*	ND*

Not Determined (ND*) Probability of correct judgment <0.05 implies change in product is significant

Low temperature tends to ensure flavour stability of fruit juice products during storage (Ebbenser, 1998; Pieper *et al.*, 1992). The prolonged stability observed in the product's sensory attributes in the bottles compared to those packaged in the sachets suggests that, rigid HDPE bottles could better protect an orange juice product from spoilage under the same storage conditions than flexible HDPE films formed into sachets. The fact that all the samples kept under the outdoor storage conditions became unwholesome by the third week confirms the assertion that favourable substrate and temperature conditions tend to optimize and enhance fruit juice spoilage by creating an enabling environment for physicochemical, microbial and enzymatic reactions to proceed (Robertson, 1993 and Correa de Souza *et al*., 2004). Citrus juice stability depends on the raw material, processing conditions, packaging material and storage condition. These factors result in microbiological, physicochemical and biochemical or enzymatic changes that determine product quality and safety (Correa de Souza *et al.*, 2004; Ebbenser, 1998). Given that the test samples were homogenous with regards to raw material and processing conditions, the packaging materials and storage conditions could have possibly contributed to some of the changes observed (Lee and Coates, 1987). The presence of dissolved oxygen in a packaged product is one main factor responsible for fruit juice deterioration (Soares and Hotchkiss, 1999). The adverse effects of dissolved oxygen in fruit juice quality have been investigated by many researchers and include degradation of ascorbic acid, increased browning and growth of aerobic bacteria and mould (Ros-Chumillas *et al.*, 2007). Lower temperature conditions tend to inhibit microbiological and enzymatic reactions that precipitate food spoilage (Ebbenser, 1998; Pieper *et al.*, 1992). The barrier properties of flexible and rigid high density polyethylene (HDPE) packages differ in gas permeability and translucency. Rigid HDPE plastics have less gas permeability than flexible HDPE films (Saunders, 1976). This probably explains why the Fresh Taste samples packaged in the HDPE bottles were more stable over the period of storage than in the sachets.

4.5 Shelf life Evaluation by Microbiological Load in Fresh Taste

The protective function of the alternative packaging design of Fresh Taste (labeled HDPE plastic bottle) was compared with that of the existing packaging design (HDPE sachet) using Yeast and Coliform loads as the measurable indicators.

Table 4.7: Initial microbial load of fresh samples of Fresh Taste in different packages

Storage Period	Package Design	Total Coliforms MPN/ml	Yeast (cfu/ml±SD)	Mould (cfu/ml±SD)	Aerobic Plate Count(cfu/ml±SD)	S. aureus (+/-)
Week 0	Bottle	6.4×10^2	32×10^5 $\pm 1.0 \times 10^4$	27×10^5 $\pm 2.0 \times 10^4$	17×10^5 $\pm 1.0 \times 10^5$	(-)
Week 0	Sachet	7.5×10^2	29×10^5 $\pm 2.0 \times 10^3$	25×10^5 $\pm 1.0 \times 10^4$	15×10^5 $\pm 2.0 \times 10^4$	(-)

From Table 4.7, it was observed that generally the initial microbial load in the orange drink products (Fresh Taste) were higher than the recommended levels by the Ghana Standards

Board which are 1.0 $x10^2$ for Coliforms and 5.0 x 10^1 for Yeast and Moulds (Ghana Standards Board, 2003). This may be due to contamination of the whole fruit during harvesting or re-contamination during the upstream (bulk extraction) and/or downstream processing (single-strength formulation) of Fresh Taste (Correa de Souza *et al.*, 2004). Cook (1958) however reported that, processed juice may contain about 10^6 /ml of yeast. Although yeast may spoil food, yeast spoilage does not pose an immediate health hazard (ICSMF, 1978). This probably explains why the sensory panelists of the triangle test did not express adverse reactions upon consuming the Fresh Taste samples even though the yeast load estimated was relatively high. The initial microbial loads (Yeast, Coliform, Moulds and aerobic bacteria) in the bottled samples were generally slightly higher than the sachet samples. This may be due to re-contamination of the product during the filling of the bottles since it was done semi-manually as against the sachet which was automatically form-fill-sealed. This puts the alternative packaging design (HDPE bottle) in a disadvantaged stance against the HDPE sachet since adopting this design would require an aseptic filling system to exclude this limitation. Notwithstanding, since both the rigid HDPE bottle and flexible HDPE sachets can withstand pasteurization temperatures, the bottled product could be pasteurized to thermally reduce the microbial population though it may add cost to the production line. Ros-Chumillas *et al.* (2007) assert that, the combination of different factors such as oxygen scavengers, liquid nitrogen drop addition in headspace during filling, aluminum foil seal in screw-cap and refrigeration temperatures with monolayer PET bottles could prolong the shelf life of orange juices to an extent comparable to glass and multilayer PET bottles. This suggests a holistic approach to enhancing the quality and shelf life of juice products rather than the adoption of an alternative packaging design based on packaging material or form only. There were no significant differences ($p>0.05$) in the yeast loads between the product samples packaged in bottle and sachet under the different storage conditions over the period (Appendix 5ii). There were also no significant differences ($p>0.05$) in the yeast loads between the three storage conditions of the test samples packaged in bottle and sachet over the storage period (Appendix 5ii). No significant differences ($p>0.05$) were detected in the Coliform loads between the product samples packaged in the bottle and sachet over the period of storage under the three conditions (Appendix 5iii). No significant differences ($p>0.05$) were detected in the Coliform loads between the three storage conditions for test samples packaged in bottle and sachet over the period of storage (Appendix 5iii). The yeast load in both bottle and sachet under all the three storage conditions increased sharply between Week 0 and 1 after which the increases were marginal for the rest of the storage period. On average, the sharp increase in yeast loads between week 0 and 1 were between 10^4 and 10^5 for all the samples. The significant availability of favourable growth requirements of yeast in the first week such as sugar, pectin, acidic pH and organic acids, probably explains the sharp increases at the onset of the storage (Ros-Chumillas *et al*., 2007). The growth however became marginal possibly because the growth enhancers of yeast particularly sugar and organic acids started depleting in tandem with the sharp decrease in the citric acid levels (TTA %) at the initial period of storage. The microbial loads in the sachet samples were found to be slightly higher than in the bottles with storage time under the three storage conditions. The barrier properties of the sachets probably allowed easier penetration of oxygen since rigid HDPE materials offer a much decreased gas permeability compared with flexible HDPE film (Robertson, 1993).

Table 4.8(a): Microbial load after storing samples under refrigeration temperature (2-5°C)

Microorganism	Total Coliforms (MPN/ml)		Yeast(CFU/ml)	
Period	Bottle	Sachet	Bottle	Sachet
Week 0	6.40 x 10^{2}	7.50 x 10^{2}	3.20 x 10^{6} ±1.0x10^{6}	2.90 x 10^{6} ±1.0x10^{6}
Week 1	6.20 x 10^{2}	9.40 x 10^{2}	1.30 x 10^{10} ±1.0x10^{8}	2.80x 10^{10}±2.0x10^{8}
Week 2	1.10 x 10^{4}	1.40 x 10^{5}	2.67 x 10^{9} ±2.0x10^{7}	2.66x 10^{10}±1.0x10^{8}
Week 3	1.10 x 10^{5}	1.10 x 10^{5}	3.30 x 10^{10} ±1.0x10^{8}	4.74x 10^{11}±1.0x10^{9}
Week 4	1.60 x 10^{7}	1.60 x 10^{7}	2.80 x 10^{10} ±2.0x10^{8}	1.25 x 10^{9}±2.0x10^{7}
Week 5	2.90 x 10^{9}	1.60 x 10^{8}	1.23 x 10^{10} ±2.0x10^{8}	3.21x 10^{10}±1.0x10^{8}
Week 6	1.50 x 10^{10}	2.30 x 10^{9}	1.58 x 10^{9} ±1.0x10^{7}	1.14x 10^{10}±2.0x10^{8}
Week 7	1.10 x 10^{12}	3.50 x 10^{12}	3.54 x 10^{9} ±2.0x10^{7}	1.69 x 10^{9}±1.0x10^{7}

Table 4.8(b): Microbial load after storing samples under room temperature (25-32°C)

Microorganism	Total Coliforms (MPN/ml)		Yeast(CFU/ml)	
Period	Bottle	Sachet	Bottle	Sachet
Week 0	6.40 x 10^{2}	7.50 x 10^{2}	3.20 x 10^{6}±2.0x10^{6}	2.90 x 10^{6}±2.0x10^{5}
Week 1	7.40 x 10^{3}	1.10 x 10^{4}	2.90 x 10^{11}±1.0x10^{9}	3.10x 10^{11}±2.0x10^{10}
Week 2	2.00 x 10^{6}	7.20 x 10^{3}	3.00 x 10^{10}±1.0x10^{9}	1.40x 10^{10}±1.0x10^{8}
Week 3	3.00 x 10^{6}	3.60 x 10^{6}	7.06 x 10^{11}±2.0x10^{8}	1.61x 10^{11}±2.0x10^{9}
Week 4	3.20 x 10^{6}	3.90 x 10^{7}	4.00 x 10^{8}±1.0x10^{7}	1.48x 10^{10}±1.0x10^{7}
Week 5	6.40 x 10^{8}	2.30 x 10^{10}	5.25 x 10^{9}±1.0x10^{7}	4.64 x 10^{9}±2.0x10^{8}
Week 6	1.10 x 10^{12}	4.30 x 10^{11}	1.06 x 10^{10}±2.0x10^{8}	6.02 x 10^{8}±2.0x10^{7}
Week 7	1.10 x 10^{12}	1.10 x 10^{12}	1.32 x 10^{10}±1.0x10^{8}	2.92 x 10^{9}±1.0x10^{7}

Table 4.8(c): Microbial load after storing samples under outdoor temperature (≥ 28°C)

Microorganism	Total Coliforms (MPN/ml)		Yeast(CFU/ml)	
Period	Bottle	Sachet	Bottle	Sachet
Week 0	6.40 x 10^{2}	7.50 x 10^{2}	3.20 x 10^{6}±1.0x10^{6}	2.90 x 10^{6}±2.0x10^{6}
Week 1	1.50 x 10^{5}	1.60 x 10^{5}	2.80 x 10^{11}±2.0x10^{9}	5.30x 10^{11}±1.0x10^{10}
Week 2	1.50 x 10^{5}	2.70 x 10^{6}	6.20 x 10^{10}±1.0x10^{8}	3.80x 10^{10}±2.0x10^{8}
Week 3	2.80 x 10^{5}	1.10 x 10^{7}	4.11 x 10^{9}±2.0x10^{8}	2.60x 10^{10}±2.0x10^{8}
Week 4	2.40 x 10^{7}	4.60 x 10^{7}	8.40 x 10^{8}±1.0x10^{7}	2.28x 10^{10}±1.0x10^{8}
Week 5	N/D**	N/D**	N/D**	N/D**

N/D** Not determined due to spoilage of samples after week 4

Generally, the samples kept under outdoor conditions had the highest levels of microbial counts followed by the samples kept under room and fridge conditions respectively. The warmer temperature conditions tended to enhance the growth of yeasts as observed by Correa de Souza *et al.* (2004).

4.6 Shelf life Evaluation by the Total Titratable Acidity Content (TTA %)

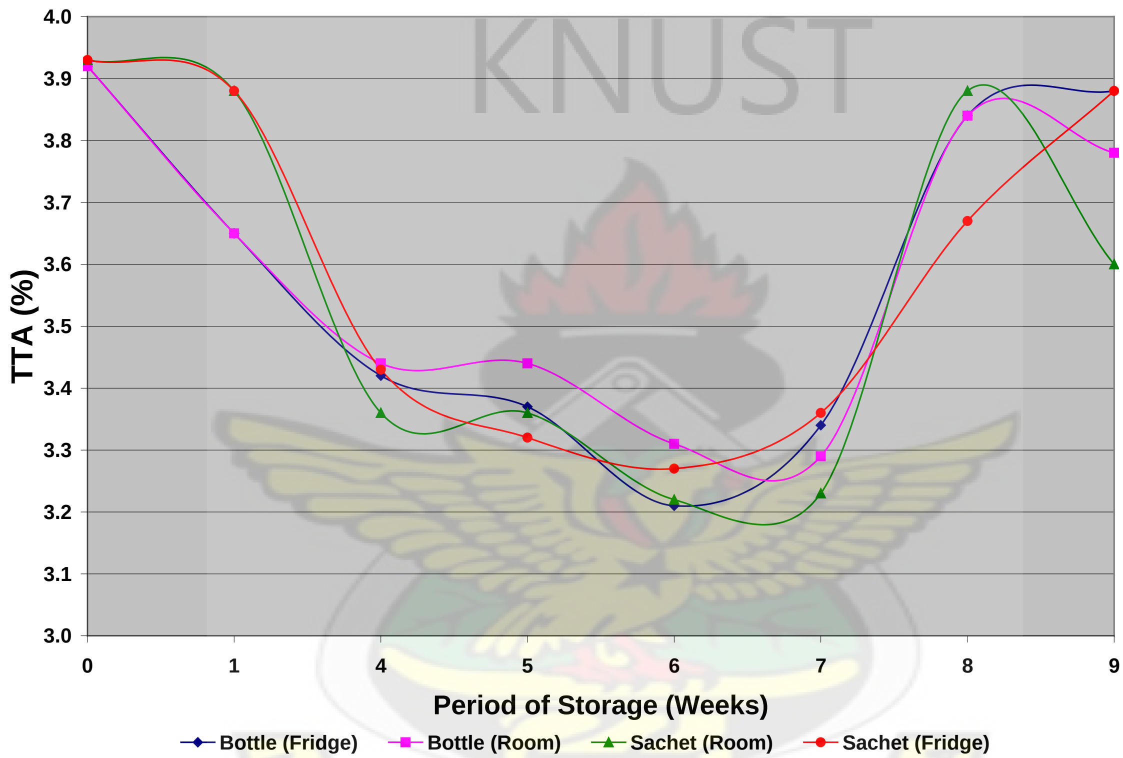

Fig 4.11: Changes in TTA% in Fresh Taste samples in two different packages

Generally, the sinusoidal pattern of evolution observed by Miguel *et al.* (2004) in the organic acid levels of pomegranate juice stored over a period at 4°C was similarly observed in the citric acid content of Fresh Taste (Fig 4.11). The total titratable acidity (TTA %) of Fresh Taste samples expressed as the predominant acid in citrus juices (citric acid) was found to have decreased sharply between the initial storage period and the fourth week. This was possibly due to consumption of the organic acids by yeast (Cook, 1958; ICSMF, 1978).

The bottle and sachet samples under fridge storage conditions continued to decrease gradually until the 6th week after which it began to increase again until the 8th week. The samples under room condition generated a minor crest between the major trough of the sinuous curve between week 4 and 7(Fig 4.11). Notably, between the 4th and 5th weeks, both the bottle and sachet samples under room storage conditions increased slightly in the citric acid levels before decreasing again till the 7th week and then began to increase sharply peaking at week 8 to begin a new trough. Yeasts consume some organic acids (acetic, lactic, citric and succinic) as substrate for growth whiles other organic acids are among the metabolites produced during microbial breakdown of food and these accumulate and eventually suppress further microbial growth (Martinez *et al.*, 1998). This possibly explains the sharp increase in TTA% after week 7 (Fig 4.11) during which the yeast load in the test samples were observed to have increased just marginally after the initial sharp rise between week 0 and 1 (Table 4.8a, b, c). No significant differences ($p>0.05$) were detected in citric acid levels between the samples in bottles and sachets kept under fridge and room conditions. No significant differences ($p>0.05$) were detected in citric acid levels between the samples kept under fridge and room conditions in both packages. Temperature however seems to be an influential factor in the evolution of organic acid content in fruit juices during storage (Zee & Simard, 1973).

4.7 Evaluation of the Communication Functions of the Two Packages

100-member untrained panelists carried out an assessment of the two packages by visual inspection of an exhibit of Fresh Taste in the bottles and sachets. Tables 4.9 to 4.11 present a summary of the output of the appraisal of the general visual appeal of the two packaging designs.

Table 4.9: Perception of package A (sachet) of Fresh Taste by Sensory Panelists

Perception of Package A (HDPE Sachet)	No. of Respondents/Panelists	Percent (%)
Poor	29	29.0
Satisfactory	33	33.0
Good	25	25.0
Very Good	12	12.0
Excellent	1	1.0
Total	100	100.0

Table 4.10: Perception of package B (labeled bottle) of Fresh Taste by Sensory Panelists

Perception of Package B (HDPE Bottle)	No. of Respondents/Panelists	Percent (%)
Satisfactory	31	31.0
Good	13	13.0
Very Good	36	36.0
Excellent	20	20.0
Total	100	100.0

29% of the laboratory acceptance panelists indicated that, the existing package (HDPE sachet) was poor. 33% rated it as satisfactory whiles 25%, 12% and 1% rated the HDPE sachet as good, very good and excellent respectively. 20%, 36% and 13% respectively rated the alternative packaging design (labelled HDPE bottle) as excellent, very good and good. 31% rated the labelled bottle as satisfactory whiles none perceived it to be poorly designed. The analysis of variance between the level of acceptance of the sachet and labelled bottle was statistically significant ($p<0.05$). The overall mean rating for the sachet and labelled bottle however were satisfactory and very good respectively. It could be inferred from the results of the laboratory acceptance panel assessment, bearing in mind the mix of people on campus coming from different parts of Ghana that the labelled HDPE bottle would be more marketable. Thus given a favourable interplay of the marketing mix of Fresh Taste on the target markets in Ghana especially Accra, Kumasi, Sekondi-Takoradi and Cape Coast, the alternative packaging design would impact positively on sales.

Table 4.11: Most obvious deficiency of Package A (Sachet)

Deficiency Identified	No. of Respondents	Percent
Illegibility of information on package (How readable)	52	52.0
Quality of material	25	25.0
Closure or seal quality	11	11.0
Handling (less convenient)	4	4.0
Artistic appeal of graphic design	5	5.0
Containment Design (shape, form ,style, etc)	3	3.0
Total	100	100.0

Fifty-two percent of the laboratory acceptance panelists indicated that, the most obvious deficiency of the existing package (HDPE sachet) was illegibility of information on the package. 25% of the panelists perceived the low quality of the packaging material to be the most obvious deficiency whiles another 11% identified the closure or seal quality of the sachet to be the most obvious deficiency (Table 4.11). This trend is in agreement with the findings of the survey conducted on KNUST campus amongst 368 consumers of pre-packaged food and beverage products made in Ghana. Illegibility of information, quality of packaging material and closure or seal quality were identified as the 1st, 2nd and 3rd most obvious deficiencies respectively in the packaging of most food and beverage products made in Ghana (Appendix 2: Tables 2.11, 2.12, 2.13). The visual sense tends to be the first recipient of the stimulus sent by the design of a product's package on a market shelf. Colours on the package tend to make the most graphic appeal thus registering the first impression of the product to the potential consumer. The most likely thing to follow in the response of the potential buyer is to read any information on the package (Anon., 2008). 73% of the respondents of the survey intimated that, the first most important information that buyers of food and beverage products look out for is expiry date followed by nutritional content (30.7%), sugar/alcohol level (17.7%) and composition of ingredients (16.8%) be it natural or artificial (Appendix 2: Tables 2.14, 2.15, 2.16). Aside the fact that consumers have a right to know what they spend on, the desire to know about the product should motivate manufacturers to want to market their products through effective communication. Legibility of information on the principal display panel (PDP) of pre-packaged products is so important that, it probably warrants the inclusion of meticulously detailed specifications on parameters that tell on legibility of information printed on packages in the USDA/FDA labeling requirements (Anon., 2008).

35.3% of the consumers of pre-packaged food and beverage products interviewed in the survey indicated that they are influenced first of all by the type of product they want to buy when they enter a retail market or shop. 10.3% and 6.8% of the respondents respectively intimated that their choice of a beverage product is influenced by the type/nature of ingredients (natural or artificial) and price/packaging design of the product (Appendix 2: Table 2.9). It could be inferred that between the same type of product such as fruit juice or malt drink, such consumers would look out for the nutritional profile of the different brands to make a choice This suggests that, a significant number of buyers know what they want to buy or at least have an idea of what they would choose when they walk into a retail market. However, beyond that, 25% indicated that the next criterion that influences their choice of a food and beverage product in a retail market is nutritional content (Appendix 2: Table 2.9, 2.10). Furthermore, according to the survey findings, the successive most important factors that influence consumer choice of a pre-packaged beverage are the nature/type of ingredients (natural or artificial), price of product and packaging design of the product (Appendix 2: Table 2.9). The increased advocacy for preventive healthcare has increased the awareness of consumers of the importance of proper dieting which is thus telling on consumer choice of pre-packaged food and beverage products (Katz, 1999). Nutritional profile thus serves to guide consumers to access their right to making informed choices of what they perceive to be healthy. When a food and beverage product on display in a retail market has been able to effectively and efficiently communicate with the potential buyer, the purchasing power of the consumer then comes under test in the quest for value for money (Budway, 2005).

Table 4.12: Retail prices of different quantities of Fresh Taste and Kalypo®

Beverage Name	Quantity(Package Type)	Price (GH¢)*
Fresh Taste	170ml /Sachet	0.05
	250ml /Sachet	0.08**
	350ml /Sachet	0.10
	500ml/Sachet	0.30
	500ml /Bottle	0.50
Kalypo®	250ml /Tetrapak	0.20
	500ml /Tetrapak	0.35**

* Retail prices in 2006 ** Estimated retail prices

The price of the product arrived at by the producer or retailer is assessed by the potential buyer based on how commensurate the quantity served per unit is with the given price (Anon, 2008; Budway, 2005; Dean, 1976).

Table 4.12 presents a comparative summary of different retail prices of various apportionments of Fresh Taste and Kalypo (a natural orange drink product on the local market packaged in a liquid carton-Tetrapak®). The ex-factory price of Fresh Taste packaged in the 500ml labeled HDPE bottles was pegged at GH¢0.50. From the real retail market prices of Fresh Taste and Kalypo, 500ml of Kalypo presented in Tetrapak packaging and sold at GH¢0.35 is likely to sell faster in the same marketing environment than Fresh Taste packaged in labeled bottle sold at GH¢0.50. This is because, buyers would receive more value for money since Kalypo is more competitively priced and attractively packaged.

Table 4.13: Assessment of the increase in retail price of pre-packaged food and beverage (F&B) products due to the added cost of improved packaging

Perception of Increased Retail Price of F&B Product in Improved Package	No. of Respondents	Percentage
Exorbitant	28	7.6
Reasonable/fair	147	39.9
Affordable	139	37.8
Not affordable	17	4.6
Not bothered	37	10.1
Total	368	100

77.7% of the laboratory acceptance panel intimated that, an increase in the retail price of the same quantity of Fresh Taste in the new packaging design due to the added cost of packaging is reasonable/fair and affordable (Table 4.13). 7% however perceived it to be exorbitant and thus should be absorbed by the manufacturer whiles 10% were indifferent about the change.

Panelists of the sensory preference test between Fresh Taste and Kalypo indicated an overall preference for Kalypo which was detected to be significantly different ($p<0.05$) on the basis of taste, texture and colour (Appendix 5iv). Because Kalypo is significantly different from Fresh Taste in terms of organoleptic attributes, Kalypo is much better placed on the food and beverage consumer market due to its more appealing Tetrapak® (liquid carton) packaging design. It could be inferred therefore from Table 4.13 and the preference test results that, improvement in the packaging of a given food and beverage product may help retain its market share but continued patronage would depend on the competitiveness of the new product in terms of price and organoleptic attributes amongst other things.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The assertion that 'the standard or quality of packaging of most food and beverage products made in Ghana is poor or unsatisfactory' was found to be false at 95% confidence. Foreign food and beverage (F&B) products are considered more competitive and preferred by consumers than most F&B products made in Ghana on the local market.

The effectiveness of the protection provided by the alternative package of Fresh Taste (HDPE plastic bottle) was not significantly different from that of the existing HDPE sachets based on the sensory, microbiological and physicochemical (total titratable acidity) analysis of Fresh Taste over a 7-week period. However, the HDPE plastic bottle extended the shelf life of Fresh Taste under room storage conditions by about 2 weeks compared to the sachet based on the sensory perceptions of the panelists.

The effectiveness of the communicative role of the full colour 135GSM art paper label of the HDPE plastic bottle was found to be more significant compared to the two-colour graphic print of the HDPE sachet. The laboratory acceptance panelists engaged for the evaluation of the two packages indicated that, the most obvious deficiencies of the existing package (HDPE sachet) were illegibility of information on the package followed by quality of packaging material and closure or seal quality.

5.2 Recommendations

- Further studies should be carried out on the effects of packages made from different packaging materials on food and beverage products made in Ghana
- A comprehensive cost-benefit analysis should be carried out on various packaging designs for food and beverage products to assists food and beverage processors in Ghana
- The food and beverage industry in Ghana generally should review and improve the quality of packaging of its products to gain a competitive edge over foreign products on the local market.
- Stakeholders in the manufacturing sector in Ghana especially producers of food and beverage products should improve on promotional activities to boost patronage of made-in-Ghana products.
- A comprehensive Good Manufacturing Practice (GMP) programme needs to be developed by Fruits and Flavours to address the sanitary lapses in the factory's production activities.
- Pasteurization should be included in the production line as an essential unit operation during the processing of Fresh Taste to reduce the microbial load.
- The alternative packaging design of Fresh Taste (labelled HDPE bottle) could be used in production alongside the HDPE sachets.
- On adopting the alternative packaging design (labelled bottle) for Fresh Taste production, an aseptic industrial filler is recommended for aseptic filling of the bottles to avoid contamination.

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APPENDICES

Appendix 1: Basis and Formulas for Calculations and Estimations

a. Pricing of Fresh Taste

Sum of: (i) Product cost per bottle

(ii) Packaging cost per bottle (label, bottle, cardboard box)

(iii) Manufacture's margin (25% of i plus ii)

(iv) Distribution cost (5% of i plus ii)

(v) Tax (VAT/NHIL) component (15% of sum of i, ii, iii and iv)

b. MPN Estimation Rules

(i) Only three consecutive dilutions could be selected. Firstly, for all dilutions having all tubes positive, the highest dilution (smallest sample volumes) was selected

(ii) The next two higher dilutions (smaller sample volumes) were used

(iii) When none of the tested dilutions yielded all tubes positive (and if possible), the first three consecutive dilutions (sample volumes) for which the middle dilution (volume) contained the positive result were selected

(iv) When a positive result occurred in a higher dilution (smaller sample volume) than the three selected, the number of positive tubes in this dilution to the highest dilution (smallest sample volume) of the three selected were added

(v) When all dilutions tested had all tubes positive, the three highest dilutions (smallest sample volumes) were selected and were indicated by a 'greater than' symbol (>)

- MPN/100ml = Number of microorganism (Statistical Table) x Dilution Factor of Middle Set of Tubes Selected.
- Dilution Factor = Reciprocal of the dilution of the analytical unit

c. Total Titratable Acidity (TTA %) as Citric Acid in Orange Juice

% Acidity (as Citric acid) = {(Titre x Factor) ÷ Weight of 10ml of sample} x 100

Citric acid factor = 0.062

d. Yeast Load/Mould Load/Total Plate Count

Colony Forming Units per ml (CFU/ml) of product sample:

This is based on the principle that, each colony arises from a single cell. Only plates with colonies between 30 and 300 were used.

CFU/ml = Average Number of Colonies x Dilution Factor

Dilution Factor = Reciprocal of Sample Dilution

e. Probability of Correct Judgment

Read as the intercept value from the Statistical Chart for Triangle test, where X is the number of times odd sample is chosen correctly in N trials or by N panelists.

Appendix 2: (a) Summary of Survey (Consumers' Category)

Table 2.1a: General Statistics of Demographic Parameters of Respondents (Consumers)

Demographic Parameters	Gender		Marital Status				Educational Background			Occupation				Economic Category		
	M	F	M	S	Sp	D	P	SS	T	S	I	St	A	L	M	H
Frequency	197	171	27	339	2	0	1	6	361	23	8	36	1	94	260	14
Percentage	53.5	46.5	7.3	92.1	0.5	0	0.3	1.6	98.1	6.3	2.2	91.3	0.3	25.5	70.7	3.8
Total	368		368				368			368				368		

Gender: M= Male, F= Female   Economic Category: L=Low, M=Middle, H=High
Marital Status: S=Single, M=Married, Sp=Separated, D=Divorced
Educational Background: P=Primary/JSS, SS=Senior Secondary, T=Tertiary
Occupation: S=Service, I=Industry, St=Student, A=Agriculture

Table 2.1b: Standard/Quality of Packaging Designs of Made in Ghana Products

Stakeholders	Standard/Quality of Packaging of MIG F&B Products		
	Poor	Not Poor	Total
Consumers	67	301	368
Converters	1	5	6
Users	1	5	6
Others	2	5	7
Total	71	316	387

X_{cal} = 0.5230, X_{cri} = 7.82 (0.523< 7.82 at P=0.05 and d_f =3)

Table 2.1c: Competitiveness of MIG food and beverage products Vrs Foreign ones

Stakeholders	Competitiveness of MIG F&B Products against Foreign ones		
	Competitive	Not Competitive	Total
Consumers	282	86	368
Converters	5	1	6
Users	5	1	6
Others	6	1	7
Total	298	89	387

(X_{cal}) = 0.6007, X_{cri} = 7.82 (0.6007< 7.82 at P=0.05 and d_f =3)

Table 2.1d: Comparing MIG and Foreign F&B Product Packaging Designs

Stakeholders	Packaging designs of MIG F&B Products against Foreign ones		
	Inferior	Comparable	Total
Consumers	67	301	368
Converters	1	5	6
Users	1	5	6
Others	3	4	7
Total	72	315	387

(X_{cal}) = 2.8009 X_{cri} = 7.82 (2.8009< 7.82 at P=0.05 and d_f =3)

Table 2.2: Gender Distribution

Gender	No. of Respondents	Percentage
Female	171	46.5
Male	197	53.5
Total	368	100.0

Table 2.3: Marital Status Distribution

Marital Status	No. of Respondents	Percentage
Separated	2	0.5
Married	27	7.3
Single	339	92.1
Total	368	100.0

Table 2.4: Occupation Distribution

Occupation	No. of Respondents	Percentage
Agriculture	1	0.3
Industry	8	2.2
Service	23	6.3
Student	336	91.3
Total	368	100.0

Table 2.5: Economic Category

Economic Group	No. of Respondents	Percentage
High income	14	3.8
Low income	94	25.5
Middle income	260	70.7
Total	368	100.0

Table 2.6: Do you take refresher drink products?

Consume F&B?	No. of Respondents	Percentage
Yes	367	99.7
No	1	0.3
Total	368	100.0

Table 2.7: Frequency of consumption of refresher drink product

Number of Times of F&B Consumption	No. of Respondents	Percentage
Once a week	43	11.7
2-3 times a week	121	32.9
4-5 times a week	67	18.2
Everyday	33	9.0
Occasionally	103	28.0
Total	368	100.0

Table 2.8: Preference for fruit juice or drink product based on texture/mouthfeel

No. of Respondents	No. of Respondents	Percentage
Juicy/turbid	174	47.3
Clear/light	122	33.2
Carbonated/gassy	52	14.1
Biting/acidic	13	3.5
Other	6	1.6
Total	368	100.0

Table 2.9: Decisive factor on choice of refresher drink product (First Criterion)

1st Decisive Factor for F&B choice	No. of Respondents	Percentage
Product	130	35.3
Nutritional information/content	119	32.3
Package	25	6.8
Volume/quantity	21	5.7
Price of product	25	6.8
Type/nature of ingredients (natural/artificial)	38	10.3
Country of origin	6	1.6
Class of people who highly patronize the product	1	0.3
Marketing drive on the product	2	0.5
Total	368	100.0

Table 2.10: Decisive factor on choice of refresher drink product (Second Criterion)

2nd Decisive Factor for F&B Choice	No. of Respondents	Percentage
Type of Product	41	11.1
Nutritional information/ content	92	25.0
Package	58	15.8
Volume/quantity of product	55	14.9
Price of product	63	17.1
Type/nature of ingredients	37	10.1
Country of origin	8	2.2
Image of company or brand name of product	5	1.4
Class of people who highly patronize product	5	1.4
Marketing drive on the product	3	0.8
Total	368	100.0

Table 2.11: First most common deficiency in the packaging of most locally made food and beverage products

1st Most Common Deficiency	No. of Respondents	Percentage
Other	1	0.3
Containment design of package	8	2.2
Quality of secondary package	8	2.2
Closure or seal quality	33	9.0
Durability and/quality of print out on package	34	9.2
Artistic appeal	51	13.9
Quality of material	109	29.6
Legibility of information on package	124	33.7
Total	368	100.0

Table2.12: Second most common deficiencies in the packaging of most food and beverage products made in Ghana

2nd Most Common deficiencies in F&B Products MIG	No. of Respondents	Percentage
Legibility of information on package	44	12.0
Quality of material	93	25.3
Artistic appeal of graphic design	76	20.7
Durability and/quality of printout on package	77	20.9
Closure or seal quality	49	13.3
Containment design of package	14	3.8
Quality of secondary package	15	4.1
Total	368	100.0

Table 2.13: Third most common deficiencies in the packaging of most locally made food and beverage products

3rd Most Common Deficiencies in F&B Products MIG	No. of Respondents	Percentage
Legibility of information on package	42	11.4
Quality of material	65	17.7
Artistic appeal of graphic design	52	14.1
Durability and/quality of printout on package	68	18.5
Closure or seal quality	78	21.2
Containment design of package	41	11.1
Quality of secondary package	22	6.0
Total	368	100.0

Table 2.14: First most important information looked out for on a packaged refresher drink product

1st Most Important Information Looked For	No. of Respondents	Percentage
Expiry date	272	73.9
Brand name	29	7.9
Sugar/alcohol level	14	3.8
Country of history	4	1.1
Volume/quantity	5	1.4
Nutritional content	31	8.4
Composition of ingredients	10	2.7
Address or contact	1	.3
Name of producer	1	.3
Total	368	100.0

Table 2.15: Second most important information looked out for on a packaged refresher drink product

2nd Most Important Information Looked For	No. of Respondents	Percentage
Expiry date	39	10.6
Brand name	54	14.7
Sugar/alcohol level	80	21.7
Country of origin	20	5.4
Volume/quantity	23	6.3
Nutritional content	113	30.7
Composition of ingredients	37	10.1
Name of producer	2	.5
Total	368	100.0

Table 2.16: Third most important information you look out for on a packaged refresher drink product

3rd Most Important Information Looked For	No. of Respondents	Percentage
Expiry date	34	9.2
Brand name	27	7.3
Sugar/alcohol level	65	17.7
Country of origin	24	6.5
Volume/quantity	30	8.2
Nutritional content	115	31.3
Composition of ingredients	62	16.8
Address/contact	7	1.9
Name of producer	4	1.1
Total	368	100.0

(b) **Corporate Respondents**

Table 2.17: Summary of corporate institutions interviewed

No.	Name of Institution or Company	Type of Institution	Ownership of Organization
1	Food Research Institute	Research	State
2	Ghana Export Promotion Council	Policy/Business Advocacy	State
3	Combert Impressions Limited	Converters/Packaging Product Manufacturer	Private
4	TV3 News Network Limited	Electronic Media (TV)	Private
5	Institute of Packaging, Ghana (IOPG)	Business/Industry Advocacy	Private
6	Ghana Standards Board	Regulatory	State
7	Cadbury Ghana Limited	Food Processor/Manufacturer	Private
8	Cocoa Processing Company Limited	Food Processor/Manufacturer	State
9	Fan Milk Ghana Limited	Food Processor/Manufacturer	Private
10	Nestle Ghana Limited	Food Processor/Manufacturer	Private
11	Promasidor Ghana Limited	Food Processor/Manufacturer	Private
12	Franpac Ghana Limited Massily Ghana Limited	Converters/Packaging Product Manufacturer	Private
13	Ghana Cartons Manufacturing Company Limited	Converters/Packaging Product Manufacturer	Private
14	Ghana Printing and Packaging Limited	Converters/Packaging Product Manufacturer	Private
15	Graphic Packaging Limited	Converters/Packaging Product Manufacturer	State
16	Poly Products Ghana Limited	Converters/Packaging Product Manufacturer	Private

(c) Packaging Converters

Table 2.18: Rating assigned by converters to MIG food and beverage product packages as against foreign ones

Packaging converters rated local packaging as:	No. of Respondents	Percent
Very comparable	2	33.3
Slightly comparable	3	50.0
Inferior	1	16.7
Total	6	100.0

Table 2.19: Most common deficiencies in the packaging of most MIG food and beverage products identified by converters

Common Deficiencies (Packaging Converters)	No. of Respondents	Percent
Legibility of information on package (How readable)	1	16.7
Quality of material	1	16.7
Artistic appeal of graphic design	2	33.3
Quality of secondary package	1	16.7
Other (seal quality)	1	16.7
Total	6	100.0

(d) Processors/Manufacturers/Users' response:

Table 2.20: Commonest packaging material used in Ghana for the packaging of food and beverage products (manufacturers)

Packaging material	No. of Respondents	Percent
Glass-based	1	16.7
Plastic-based only	4	66.7
Plastic and Paper	1	16.7
Total	6	100.0

Table 2.21: Most food and beverage products made in Ghana are comparatively less competitive on the local and international market (manufacturers)

Level of agreement	No. of Respondents	Percent
Agree extremely	1	16.7
Agree fairly	4	66.7
Disagree fairly	1	16.7
Total	6	100.0

Table 2.22: Rating assigned to locally manufactured/designed food and beverage product packages as against foreign ones (users)

Rating of MIG F&B Products against Foreign Ones	No. of Respondents	Percent
Very comparable	1	16.7
Slightly comparable	5	83.3
Total	6	100.0

Table 2.23: First Most common deficiencies in the packaging of most locally manufactured food and beverage products identified by manufacturers

1st Most Common Deficiency	No. of Respondents	Percent
Legibility of information on package(How readable)	1	16.7
Durability and/or quality of print out on package (faint)	2	33.3
Closure or seal quality	3	50.0
Total	6	100.0

Table 2.24: Second most common deficiencies in the packaging of most locally manufactured food and food products identified by manufacturers

Second most common deficiencies in the packaging of MIG products	No. of Respondents	Percent
Legibility of information on package(How readable)	1	16.7
Quality of material	1	16.7
Artistic appeal of graphic design	2	33.3
Quality of secondary package	1	16.7
Containment design of package	1	16.7
Total	6	100.0

(d) Other General Corporate respondents

Table 2.25: Commonest packaging material or design used in Ghana for the packaging of food and food products, especially refresher drink products

Commonest Packaging Material in Ghana	No. of Respondents	Percent
Glass-based	1	14.3
Plastic-based	6	85.7
Total	7	100.0

Table 2.26: Rating assigned to locally manufactured/designed food and food product packages as against foreign ones

Rating of F&B MIG Products against Foreign Ones	No. of Respondents	Percent
Slightly comparable	4	57.1
Inferior	3	42.9
Total	7	100.0

Table 2.27: Most food and beverage products made in Ghana are comparatively less competitive on the local and international market

Competitiveness of Local F&B Products	No. of Respondents	Percent
Agree extremely	3	42.9
Agree fairly	3	42.9
Disagree fairly	1	14.3
Total	7	100.0

Table 2.28: First most common deficiencies in the packaging of most locally manufactured food and beverage products

1st Most Common Deficiency	No. of Respondents	Percent
Legibility of information on package(How readable)	1	14.3
Quality of material	1	14.3
Artistic appeal of graphic design	1	14.3
Durability and/or quality of print out on package (faint)	1	14.3
Containment design of package	1	14.3
Closure or seal quality	2	28.6
Total	7	100.0

Table 2.29: Second most common deficiencies in the packaging of most locally manufactured food and food products

2nd Most Common Deficiency	No. of Respondents	Percent
Legibility of information on package(How readable)	1	14.3
Artistic appeal of graphic design	3	42.9
Durability and/or quality of print out on package (faint)	1	14.3
Quality of secondary package	1	14.3
Containment design of package	1	14.3
Total	7	100.0

Table 2.30: Compliance of manufacturers of food products with laws governing food packaging

Compliance of Manufacturers	No. of Respondents	Percent
Yes(most)	1	14.3
No	2	28.6
Yes (few)	4	57.1
Total	7	100.0

Table 2.31: Possible deficiencies existent in the food packaging industry in Ghana

Deficiencies in the food packaging industry in Ghana	No. of Respondents	Percent
Lack of personnel with requisite expertise	1	14.3
Lack of adequate enforcement of laws/standards/policies	3	42.9
Inadequate investment into modern packaging technology	1	14.3
Inadequate consumer awareness/appreciation of standard packaging	1	14.3
High tax charges on packaging materials and products	1	14.3
Total	7	100.0

(e) Table 2.32: List of converters and marketing companies of food packaging products in Ghana interviewed for package design options

	Name	Product(s)/Services	Location
1	Graphic Packaging Ltd	Graphic Printing (Labels, Cardbox)	Accra
2	Ghana Cartons Manufacturing Company Ltd	Paper Carton manufacturer	Accra
3	Poly Products Ghana Ltd	Plastic products manufacturer	Accra
4	Ghana Printing and Packaging Ltd	Graphic Printing (Labels, Cardbox)	Tema
5	Franpac Ghana Ltd/ Massily Ghana Ltd	PET Bottles and Plastic Crowns	Tema
6	Combert Impressions Ltd	Graphic Printing (Labels, Cardbox)	Accra

Appendix 3(a): Data of Total Titratable Acidity (TTA % as Citric Acid)

Table 1: Titre Values of Total Titratable Acidity (TTA %) (Bottle in Fridge)

Storage Period Ending	Titre 1	Titre 2	Titre 3	Average Titre	%TTA
Week 0	6.31	6.33	6.32	6.32	3.92 ± 0.02
Week 1	5.90	5.87	5.87	5.88	3.65 ± 0.02
Week 4	5.55	5.50	5.50	5.52	3.42 ± 0.03
Week 5	5.45	5.40	5.45	5.43	3.37 ± 0.03
Week 6	5.15	5.25	5.15	5.18	3.21 ± 0.06
Week 7	5.38	5.40	5.40	5.39	3.34 ± 0.01
Week 8	6.20	6.19	6.21	6.20	3.84 ± 0.01
Week 9	6.24	6.25	6.26	6.25	3.88 ± 0.01

Table 2: Titre Values of Total Titratable Acidity (TTA %) (Bottle (Room)

Storage Period Ending	Titre 1	Titre 2	Titre 3	Average Titre	%TTA
Week 0	6.33	6.32	6.31	6.32	3.92 ± 0.02
Week 1	5.9	5.87	5.87	5.88	3.65 ± 0.02
Week 4	5.4	5.65	5.6	5.55	3.44 ± 0.13
Week 5	5.75	5.45	5.45	5.55	3.44 ± 0.17
Week 6	5.3	5.35	5.35	5.33	3.31 ± 0.03
Week 7	5.3	5.33	5.31	5.31	3.29 ± 0.02
Week 8	6.18	6.2	6.22	6.20	3.84 ± 0.02
Week 9	6.08	6.1	6.12	6.10	3.78 ± 0.02

Table 3: Titre Values of Total Titratable Acidity (TTA %) (Sachet (Fridge)

Storage Period Ending	Titre 1	Titre 2	Titre 3	Average Titre	%TTA
Week 0	6.34	6.32	6.35	6.34	3.93 ± 0.02
Week 1	6.28	6.25	6.25	6.26	3.88 ± 0.02
Week 4	5.5	5.55	5.55	5.53	3.43 ± 0.03
Week 5	5.3	5.4	5.35	5.35	3.32 ± 0.05
Week 6	5.25	5.25	5.3	5.27	3.27 ± 0.03
Week 7	5.45	5.4	5.39	5.41	3.36 ± 0.03
Week 8	5.9	5.93	5.93	5.92	3.67 ± 0.02
Week 9	6.2	6.25	6.3	6.25	3.88 ± 0.05

Table 4: Titre Values of Total Titratable Acidity (TTA %) (Sachet (Room)

Storage Period Ending	Titre 1	Titre 2	Titre 3	Average Titre	%TTA
Week 0	6.32	6.35	6.34	6.34	3.93 ± 0.02
Week 1	6.28	6.25	6.25	6.26	3.88 ± 0.02
Week 4	5.5	5.3	5.45	5.42	3.36 ± 0.10
Week 5	5.4	5.4	5.45	5.42	3.36 ± 0.03
Week 6	5.15	5.25	5.2	5.20	3.22 ± 0.05
Week 7	5.2	5.22	5.2	5.21	3.23 ± 0.01
Week 8	6.3	6.25	6.2	6.25	3.88 ± 0.05
Week 9	5.78	5.8	5.82	5.80	3.60 ± 0.02

Table 5: Mean Values of Total Titratable Acidity (TTA %) of Fresh Taste per Week

Storage Week	Bottle (fridge) %	Bottle (room) %	Sachet (room) %	Sachet (fridge) %
Week 0	3.92 ± 0.01	3.92 ± 0.01	3.93 ± 0.02	3.93 ± 0.02
Week 1	3.65 ± 0.02	3.65 ± 0.02	3.88 ± 0.02	3.88 ± 0.02
Week 4	3.42 ± 0.03	3.44 ± 0.13	3.36 ± 0.10	3.43 ± 0.03
Week 5	3.37 ± 0.03	3.44 ± 0.17	3.36 ± 0.03	3.32 ± 0.05
Week 6	3.21 ± 0.06	3.31 ± 0.03	3.22 ± 0.05	3.27 ± 0.03
Week 7	3.34 ± 0.01	3.29 ± 0.02	3.23 ± 0.01	3.36 ± 0.03
Week 8	3.84 ± 0.01	3.84 ± 0.02	3.88 ± 0.05	3.67 ± 0.02
Week 9	3.88 ± 0.01	3.78 ± 0.02	3.60 ± 0.02	3.88 ± 0.05

Appendix 3(b): Consistency of Fresh Taste batches of production for Triangle test

Table1: pH of the fresh samples of Fresh Taste (per week) used as control in Triangle test

Period Ending	Mean (SD)	pH		
		Rep 1	Rep 2	Rep 3
Week 0	4.02±0.03	4	4.02	4.05
Week 1	4.05±0.02	4.03	4.07	4.06
Week 2	4.10±0.02	4.08	4.12	4.1
Week 3	4.05±0.01	4.04	4.06	4.05
Week 4	4.11±0.02	4.13	4.09	4.12
Week 5	4.07±0.01	4.06	4.08	4.06
Week 6	4.07±0.02	4.05	4.07	4.08
Week 7	4.10±0.02	4.12	4.1	4.08

SD: Standard Deviation

Table 2: Sugar content (%) of the fresh samples of Fresh Taste (per week) used as control in Triangle test

Period Ending	Mean (SD)	Sugar Content (%)		
		Rep 1	Rep 2	Rep 3
Week 0	5.10±0.02	5.12	5.1	5.08
Week 1	5.04±0.04	5	5.07	5.05
Week 2	5.09±0.02	5.09	5.07	5.1
Week 3	5.03±0.01	5.02	5.04	5.03
Week 4	5.07±0.01	5.06	5.08	5.07
Week 5	5.12±0.03	5.12	5.14	5.09
Week 6	5.05±0.02	5.07	5.06	5.03
Week 7	5.10±0.02	5.08	5.1	5.12

Appendix 3(c): Triangle test results

Table 4.6(a): Triangle test results at week zero (0) of storage

Storage Condition	Package	Odd Sample Chosen		Total	Probability of correct judgment	Inference
		Correctly	Incorrectly			
Batch I (Fridge)	Bottle	7	18	25	0.778	Wholesome
	Sachet	8	17	25	0.630	Wholesome
Batch II (Room)	Bottle	9	16	25	0.462	Wholesome
	Sachet	10	15	25	0.304	Wholesome
Batch III (Outdoor)	Bottle	12	13	25	0.092	Wholesome
	Sachet	11	14	25	0.178	Wholesome

Table 4.6 (b): Triangle test results after second (2^{nd}) week of storage

Storage Condition	Package	Odd Sample Chosen		Total	Probability of correct judgment	Inference
		Correctly	Incorrectly			
Batch I (Fridge)	Bottle	4	16	20	0.940	Wholesome
	Sachet	4	16	20	0.940	Wholesome
Batch II (Room)	Bottle	9	11	20	0.191	Wholesome
	Sachet	9	11	20	0.191	Wholesome
Batch III (Outdoor)	Bottle	10	10	20	0.092	Wholesome
	Sachet	8	12	20	0.339	Wholesome

Table 4.6(c): Triangle test results after third (3rd) week of storage

Storage Condition	Package	Odd Sample Chosen Correctly	Incorrectly	Total	Probability of correct judgment	Inference
Batch I (Fridge)	**Bottle**	**9**	**12**	**21**	**0.240**	**Wholesome**
	Sachet	**8**	**13**	**21**	**0.399**	**Wholesome**
Batch II (Room)	**Bottle**	**7**	**14**	**21**	**0.581**	**Wholesome**
	Sachet	**10**	**11**	**21**	**0.125**	**Wholesome**
Batch III (Outdoor)	**Bottle**	**17**	**4**	**21**	**0.002**	**Unwholesome**
	Sachet	**18**	**3**	**21**	**0.002**	**Unwholesome**

Table 4.6 (d): Triangle test results after fourth (4th) week of storage

Storage Condition	Package	Odd Sample Chosen Correctly	Incorrectly	Total	Probability of correct judgment	Inference
Batch I (Fridge)	**Bottle**	25	15	**40**	0.001	**Unwholesome**
	Sachet	16	24	**40**	0.231	**Wholesome**
Batch II (Room)	**Bottle**	18	22	**40**	0.083	**Wholesome**
	Sachet	27	13	**40**	0.001	**Wholesome**
Batch III (Outdoor)	**Bottle**	28	12	**40**	0.001	**Unwholesome**
	Sachet	**ND***	**ND***	**ND***	**ND***	**Unwholesome**

ND*: Not determined due to spoilage of sample during storage

Table 4.6(e): Triangle test results after fifth (5th) week of storage

Storage Condition	Package	Odd Sample Chosen Correctly	Incorrectly	Total	Probability of correct judgment	Inference
Batch I (Fridge)	**Bottle**	14	22	36	0.293	**Wholesome**
	Sachet	13	23	36	0.422	**Wholesome**
Batch II (Room)	**Bottle**	14	22	36	0.293	**Wholesome**
	Sachet	22	14	36	0.001	**Unwholesome**
Batch III (Outdoor)	**Bottle**	**ND***	**ND***	**ND***	**ND***	**Unwholesome**
	Sachet	**ND***	**ND***	**ND***	**ND***	**Unwholesome**

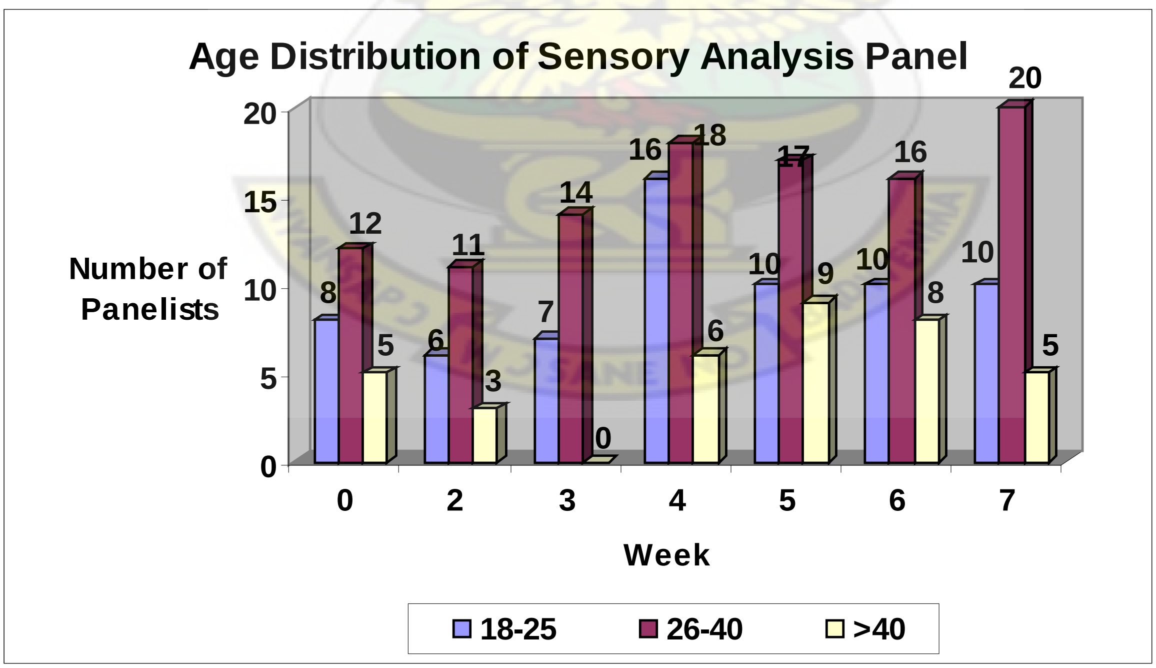
Table 4.6(f): Triangle test results after sixth (6th) week of storage

Storage Condition	Package	Odd Sample Chosen Correctly	Incorrectly	Total	Probability of correct judgment	Inference
Sample I (Fridge)	Bottle	5	29	34	0.996	Wholesome
	Sachet	12	22	34	0.468	Wholesome
Batch II (Room)	Bottle	14	20	34	0.213	Wholesome
	Sachet	21	13	34	0.001	Unwholesome
Batch III (Outdoor)	Bottle	ND*	ND*	ND*	ND*	Unwholesome
	Sachet	ND*	ND*	ND*	ND*	Unwholesome

Table 4.6 (g): Triangle test results after seventh (7th) week of storage

Storage Condition	Package	Odd Sample Chosen Correctly	Incorrectly	Total	Probability of correct judgment	Inference
Batch I (Fridge)	Bottle	4	31	35	0.999	Wholesome
	Sachet	13	22	35	0.376	Wholesome
Batch II (Room)	Bottle	16	19	35	0.087	Wholesome
	Sachet	ND*	ND*	ND*	ND*	Unwholesome
Batch III (Outdoor)	Bottle	ND*	ND*	ND*	ND*	Unwholesome
	Sachet	ND*	ND*	ND*	ND*	Unwholesome

Appendix 4: Graphical illustrations of data analysis outputs



Age distribution of sensory panelists for the 7-week triangle test (Fresh Taste)

Appendix 5: Statistical Analysis Outputs of Data

Summary of ANOVA and LSD

(i)TTA% in Fresh Taste Packaged in HDPE Plastic Bottles and Sachets

Variate: TTA%

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Package	1	0.0062	0.0062	0.04	0.843
Conditio	1	0.0149	0.0149	0.10	0.758
Residual	81	12.6933	0.1567		
Total	83	12.7144			

***** Tables of means *****

Variate: TTA

Grand mean 5.690

Package	Bottle	Sachet
	5.699	5.682

Condition	Fridge	Room
	5.704	5.677

*** Standard errors of differences of means ***

Table	Package	Condition
rep.	42	42
d.f.	81	81
s.e.d.	0.0864	0.086

(ii)Yeast Load in Fresh Taste Packaged in HDPE Plastic Bottles and Sachets

Between Bottle and Sachet for Fridge condition

Variate: Yeast_Fridge

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Package	1	0.263	0.263	0.13	0.725
Residual	14	28.549	2.039		
Total	15	28.811			

Variate: Fridge

Grand mean 9.61

Package	Bottle	Sachet
	9.48	9.74

*** Standard errors of differences of means ***

Table	Package
rep.	8
d.f.	14
s.e.d.	0.714

Between Bottle and Sachet for Room condition

Variate: Yeast_Room

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Package	1	0.00	0.00	0.00	0.994
Residual	14	174.76	12.48		
Total	15	174.76			

***** Tables of means *****

Variate: Room

Grand mean 7.36

Package	Bottle	Fridge
	7.36	7.37

*** Standard errors of differences of means ***

Table	Package
rep.	8
d.f.	14
s.e.d.	1.767

Between Bottle and Sachet for Outdoor condition

Variate: Yeast_Outdoor

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Package	1	0.510	0.510	0.13	0.726
Residual	8	30.850	3.856		
Total	9	31.360			

***** Tables of means *****

Variate: Outdoor

Grand mean 9.68

Package	Bottle	Fridge
	9.46	9.91

*** Standard errors of differences of means ***

Table	Package
rep.	5
d.f.	8
s.e.d.	1.242

Between Fridge, Room and Outdoor Conditions for Bottle and Sachet

Variate: Between Conditions for Yeast

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Conditions	2	0.529	0.265	0.08	0.927
Residual	27	94.456	3.498		
Total	29	94.985			

***** Tables of means *****

Variate: Yeast

Grand mean 9.68

Conditions	Room	Fridge	Outdoor
	9.84	9.51	9.68

*** Standard errors of differences of means ***

Table	Conditions
rep.	10
d.f.	27
s.e.d.	0.836

*** Least significant differences of means ***

Table	Conditions
rep.	10
d.f.	27
l.s.d.	1.716

(iii) Coliform Load in Fresh Taste Packaged in HDPE Plastic Bottles and Sachet

Between Room, Fridge and Outdoor Conditions for Bottle and Sachet

Variate: Between Conditions for Coliform

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Conditions	2	5.110	2.555	0.86	0.436
Residual	27	80.523	2.982		
Total	29	85.632			

***** Tables of means *****

Variate: Coliform

Grand mean 5.04

Conditions	Room	Fridge	Outdoor
	5.09	4.51	5.52

*** Standard errors of differences of means ***

Table	Conditions
rep.	10
d.f.	27
s.e.d.	0.772

*** Least significant differences of means ***

Table	Conditions
rep.	10
d.f.	27
l.s.d.	1.585

Between Bottle and Sachet (Room)

Variate: Coliform_Room

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Package	1	0.00	0.00	0.00	0.994
Residual	14	174.76	12.48		
Total	15	174.76			

***** Tables of means *****

Variate: Room

Grand mean 7.36

Package	Bottle	Sachet
	7.36	7.37

*** Standard errors of differences of means ***

Table	Package
rep.	8
d.f.	14
s.e.d.	1.767

Between Bottle and Sachet (Fridge)

Variate: Coliform_Fridge

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Package	1	0.00	0.00	0.00	0.988
Residual	14	166.18	11.87		
Total	15	166.18			

***** Tables of means *****

Variate: Fridge

Grand mean 6.68

Package	Bottle	Sachet
	6.70	6.67

*** Standard errors of differences of means ***

Table	Package
rep.	8
d.f.	14
s.e.d.	1.723

Table 5: Between Bottle and Sachet (Outdoor)

Variate: Outdoor

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Package	1	1.043	1.043	0.34	0.578
Residual	8	24.857	3.107		
Total	9	25.899			

***** Tables of means *****

Variate: Coliform_outdoor

Grand mean 5.52

Package	Bottle	Sachet
	5.20	5.84

*** Standard errors of differences of means ***

Table	Package
rep.	5
d.f.	8
s.e.d.	1.115

(iv)Preference Test between Fresh Taste and Kalypo (Taste, Texture and Colour)

Variate: Taste

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Product	1	68.007	68.007	26.14	<.001
Residual	148	384.987	2.601		
Total	149	452.993			

***** Tables of means *****

Variate: Taste

Grand mean 3.33

Product	1.00	2.00
	4.00	2.65

*** Standard errors of differences of means ***

Table	Product
rep.	75
d.f.	148
s.e.d.	0.263

Variate: Texture

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Product	1	58.907	58.907	23.42	<.001
Residual	148	372.267	2.515		
Total	149	431.173			

***** Tables of means *****

Variate: Texture

Grand mean 3.21

Product	1.00	2.00
	3.84	2.59

*** Standard errors of differences of means ***

Table	Product
rep.	75
d.f.	148
s.e.d.	0.259

Variate: Color

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Product	1	28.167	28.167	11.52	<.001
Residual	148	361.707	2.444		
Total	149	389.873			

***** Tables of means *****

Variate: Color

Grand mean 3.09

Product	1.00	2.00
	3.52	2.65

*** Standard errors of differences of means ***

Table	Product
rep.	75
d.f.	148
s.e.d.	0.255

(v) pH and Sugar content(%) of fresh batches of Fresh Taste production per week

Identifier	Values	Missing	Levels
Week	24	0	8

Identifier	Minimum	Mean	Maximum	Values	Missing
pH	4.000	4.072	4.130	24	0

Identifier	Minimum	Mean	Maximum	Values	Missing
sugar	5.000	5.075	5.140	24	0

Variate: pH

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Week	7	0.0196000	0.0028000	8.10	<.001
Residual	16	0.0055333	0.0003458		
Total	23	0.0251333			

***** Tables of means ****
Variate: pH

Grand mean 4.0717

Week:0	1	2	3	4	5	6	7
4.0233a	4.0533ab	4.1000c	4.0500abd	4.1133ce	4.0667bcde	4.0667bcde	4.1000ce

Means with the same subscripts are not significantly different ($p < 0.05$).

```
*** Standard errors of differences of means ***

Table                  Week
rep.                      3
d.f.                     16
s.e.d.              0.01518

*** Least significant differences of means ***

Table                  Week
rep.                      3
d.f.                     16
l.s.d.              0.03219


Variate: sugar

Source of variation     d.f.       s.s.       m.s.    v.r.  F pr.
Week                       7  0.0205958  0.0029423    6.54  <.001
Residual                  16  0.0072000  0.0004500
Total                     23  0.0277958

***** Tables of means *****

Variate: sugar

Grand mean  5.0746
```

Week:0	1	2	3	4	5	6	7
5.1000a	5.0400b	5.0867ac	5.0300bd	5.0700abce	5.1167acf	5.0533bcde	5.1000acef

Means with the same subscripts are not significantly different ($p < 0.05$).

```
*** Standard errors of differences of means ***

Table                  Week
rep.                      3
d.f.                     16
s.e.d.              0.01732

*** Least significant differences of means ***

Table                  Week
rep.                      3
d.f.                     16
l.s.d.              0.03672
```

(vi) Evaluation of communication function between existing and new package designs

Summary of ANOVA

Variate: Level_of Acceptance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Packagin	1	74.420	74.420	63.39	<.001
Residual	198	232.460	1.174		
Total	199	306.880			

***** Tables of means *****

Variate: Level_of acceptance

Grand mean 2.840

Packagin	1.00	2.00
	2.230	3.450

*** Standard errors of differences of means ***

Table	Packagin
rep.	100
d.f.	198
s.e.d.	0.1532

Appendix 6: Questionnaires Administered

FORM A1

Questionnaire on packaging of food and beverage products made in Ghana.

This questionnaire seeks to know the opinion of consumers on the status of packaging of most food and beverage products made in Ghana. It also seeks to gather information on the criteria used by consumers to make a decision on product choice.

(**Confidentiality is assured**).

Please check (√) or fill boxes with numbers to indicate order of preference/precedence (1, 2, 3...) or fill blank spaces where applicable.

(A) Personal Information

(i)Age □ Below 18 □ 18-25 □ 26-40 □ Above 40

(ii)Gender □ Male □ Female

(iii)Marital Status □ Single □ Married □ Separated □ Divorced □ Widowed

(iii)Educational background

□ Primary/Junior Secondary □ Senior Secondary □ Tertiary

(iv) Occupation/Profession (please indicate name of academic institution or job type where applicable) …………………………………………………

□ Service (school, hospital, etc) □ Industry (food & mineral processing ,etc) □ Student □ Agriculture (farming, fishing, etc)

(v) Economic Category / Class (Please use your discretion)

□ Low income □ Middle Income □ High Income

(vi) Employer (if any)

□ Self □ Government □ Private Company □ Self & Government □ Self & Private

(B) You and Refresher Drink Products

(i)Do you take refresher drink products (cola , malt, cocoa, beer, juice, etc) ?

□ Yes □ No

(ii)If yes, how many times do you take refresher drink products?

□ Once/week □ 2-3 times/week □ 4-5 times/week □ Everyday □ Occasionally

(iii) Mark the texture /mouth feel type you prefer for a fruit juice or drink product

□ Juicy/turbid □Clear/light □Carbonated/Gassy □Biting/acidic □ Other……………

(iv) Indicate (using 1,2 and 3 in the boxes), which of the following influences your choice of a refresher drink product.

□ Product (beer, yoghurt, juice, etc) □ Nutritional information or content

□ Package (type of material, graphic design, packaging design, etc

□ Volume/quantity of the product □ Price of the product

□ Type/nature of the ingredients (natural or artificial, fruit type, etc)

□ Country of origin □ Image of the company or brand name of the product

□ Class of people who highly patronize the product

□ Marketing drive on the product (sales promotion, adverts, public relations)

(v) Does packaging influence your choice of a refresher drink product from a given range of drinks?

□ Yes (always) □ No □ Yes (sometimes) □ Yes (most times)

(C) Perception of locally packaged food and beverage products made in Ghana

(i)The standard or quality of packaging of most food and beverage products made in Ghana is

□ Excellent □ Good □ Satisfactory □ Poor

(ii) Most food and beverage products **made in Ghana** are comparatively **less competitive** on the local market particularly because of packaging. Please indicate your **level** of agreement or otherwise

□Agree extremely □Agree fairly □ Indifferent □ Disagree fairly □ Disagree extremely

(iii) What rating would you assign to **locally manufactured/designed** food packages as **against foreign** ones? Local packaging is

□ Superior □ Very Comparable □ Slightly Comparable □ Inferior

(iv) If **you agree with** the above perception or assertion (C, ii), indicate the three **most common deficiencies** in the **packaging** of most locally manufactured food and beverage products. (Indicate using 1,2 and 3 only in order of precedence)

□ Legibility of information on package (How readable)

□ Quality of material (paper, plastic, glass, metal, etc)

□ Artistic appeal of graphic design (How aesthetic)

□ Durability and/or quality of print out on package (fading, bleaching, faint etc)

□ Closure or seal quality

□ Containment design of package (Shape, form, size or style of package)

□ Quality of secondary package (boxes,cartons, stretch-wrap, polybags , etc)

□ Other (please indicate)……………………………………………………..

(v) Do you prefer to buy food and beverage products that are manufactured and/or ***packaged*** outside ***Ghana (foreign)*** over locally made ones?

□ Yes (always) □ No □ Yes (most times) □ Yes (few times)

(vi) If Yes , why ?

□ Lower Price □ Better packaging □ Larger quantity or volume

□ Country of Origin □ Better marketing drive (adverts, promotions)

□ Quality of product □ Other (please indicate)…………………………………

(D) Information on Package

Indicate (using 1,2 & 3 only in order of priority), the **three most important** information you look out for on a packaged refresher drink product.

□ Expiry date □Brand name □ Sugar/Alcohol level □ Country of Origin

□ Volume/Quantity □ Nutritional Content □ Composition of ingredients

□ Address or Contact □ Name of Producer □ Other (please indicate)………………....

(E) Packaging Design/Retail Price

(i) Which packaging design made from ***plastics*** do you prefer?

□ Sachets □ Bottle □ Cup

□ Flexible Tube/Pouch (Eg Poki) □ Other(please indicate)…………..…………………

(ii)What is your assessment of the total **retail price** of packaged refresher drink products due to the added cost of packaging ?

□ Exorbitant □ Reasonable/Fair □ Affordable □ Not affordable □ Not bothered

☺ **Thank you very much** ☺

FORM A2

This questionnaire seeks to know the corporate **opinion** of the **status** of packaging of most food and beverage products made in Ghana. It also seeks to gather information on the **familiarity** of some food-related institutions and organizations in Ghana with the **packaging of most food and beverage products made in Ghana**.

(**Confidentiality is assured**).

NB: Please check (√) or fill boxes with numbers to indicate order of preference/precedence (1, 2, 3...) or fill blank spaces where applicable.

(A) Information on Institution/ Organization

(i) Name of Organization…………………………………………………………

(ii) Please check the ownership of the institution

□ Private □ Government □ Private and Government □Other(please specify)……..

(iii)Type of Institution or Organization

□ Regulatory □ Package Manufacture (Converters) □ Food Manufacturer (Users) □ Research □ Policy/Business Advocacy □ Other(please indicate)…………………

(iv) Contact Address:……………………………………………………………………

(v) Office Phone Nos…………………………………………………………………...

(vi) Office/Position of Respondent……………………………………………………….

Location:……………………………… E-mail/Website:……………..…………………...

(B) Familiarity with the Food Packaging Industry

(i)Are you familiar with the issues of food and food product packaging in the world or African market (drinks, confectionery, fish, meat, dairy products, etc)?

□ Yes (very familiar) □ No □ Yes (somehow familiar)

(ii)Are you familiar with the packaging of food and beverage products made in Ghana?

□Yes (very familiar) □ No □ Yes (somehow familiar)

(iii)What is the commonest packaging material or design used in Ghana for the packaging of food and beverage products, especially refresher drink products?

□ Glass-based □ Paper-based □ Plastic-based □ Metal-based

□ Other (please specify)……………………………………………

(iv) "Effective /efficient packaging is necessary in the development and marketing of food and beverage products made in Ghana "Please indicate your level of agreement with the above statement

□Agree extremely □ Agree fairly □ Indifferent □Disagree fairly □Disagree extremely

(C) Perception of most locally packaged food and beverage products made in Ghana

(i)The standard/quality of **packaging of most** food products made in Ghana is

□ Excellent □ Good □ Satisfactory □ Poor

(ii) Food and beverage products **made in** Ghana are comparatively **less competitive** on the **local** market because of packaging. Please indicate your level of agreement or otherwise

□Agree extremely □ Agree fairly □ Indifferent □Disagree fairly□ Disagree extremely

Please turn over

(iii) What rating would you assign to **locally manufactured/designed** food and food product packages as **against foreign** ones? Local packaging is

□ Superior □ Very Comparable □ Slightly Comparable □ Inferior

(iv) If **you agree with the** above perception or assertion (C, ii) , indicate the **three most common deficiencies** in the **packaging** of most locally manufactured food and beverage products. (Indicate using 1,2 and 3 only in order of priority/precedence)

□ Legibility of information on package (How readable)

□ Quality of material (paper, plastic, glass, metal, etc)

□ Artistic appeal of graphic design (How aesthetic)

□ Durability and/or quality of print out on package (fading, bleaching, faint etc)

□ Quality of secondary package (boxes, cartons, stretch-wrap, polybags , etc)

□ Containment design of package (Shape, form, size or style of package)

□ Closure or seal quality □ Other (please indicate)…………………………..

(D) Functions of Institutions/Organization related to Food Product Packaging

(i)Are you aware of/familiar with laws or standards or policies that apply to the packaging of food and beverage products made in Ghana?

□ Yes (very familiar) □ No □ Yes (somehow familiar)

(ii) Are producers/manufacturers of food and beverage products in Ghana complying with the laws, standards or policies governing food packaging?

□ Yes (most) □ No □ Yes (few) □ Yes (all) □ Other (please specify)…………

(iii) If yes to the above question (D, iii) what **deficiencies** noticeably exist in the **food packaging industry in Ghana**? Please indicate using 1, 2, 3... in the boxes in order of priority/precedence.

□Lack of appropriate laws/standards/policy □ Lack of personnel with requisite expertise

□ Lack of adequate enforcement of laws/standards/policy on food and food product packaging

□ Lack of adequate capital/financial investment into standard/modern packaging technology

□ Lack of adequate market for food packaging materials or products

□ Lack of adequate consumer right awareness/appreciation of standard packaging

□ Lack of appropriate regulatory institutions or agencies for the packaging industry

□ High tax charges on packaging materials and their products

□ Other(please indicate)……………………………………………………………………

☺ **Thank you very much** ☺

FORM A3

This questionnaire seeks to know the **corporate opinion** of some food manufacturing companies (users) on the **status** of packaging of most food and beverage products made in Ghana. It also seeks to gather information on the **familiarity** of some users in Ghana with the **packaging of most food and beverage products made in Ghana**.

(**Confidentiality is assured**).

NB: Please check (√) or fill boxes with numbers to indicate order of preference/precedence (1, 2, 3...) or fill blank spaces where applicable

(A) Information on Company

(i) Name of Company :……………………………………………………………

(ii) Please check the ownership of the institution

□ Private □ Government □ Private and Government □ Other(please specify)……..

(iv) Contact Address:………………………………………………………………………

(v) Office Phone Nos….……………………………………………………………………

Location:………………………………E-mail/Website:………...…………………………...

(B) Familiarity with the Food Packaging Industry

(i) Are you familiar with the issues of food and food product packaging in the world or African market (drinks, confectionery, fish, meat, dairy products, etc)?

□ Yes (very familiar) □ No □ Yes (somehow familiar)

(ii) Are you familiar with the packaging of most food and beverage products made in Ghana?

□Yes (very familiar) □ No □ Yes (somehow familiar) (iii)What is the commonest packaging material or design used in Ghana for the packaging of food and beverage products, especially refresher drink products?

□ Glass-based □ Paper-based □ Plastic-based □ Metal-based

□ Other (please specify)…………………………………………………

(iv) "Effective /efficient packaging is necessary in the development and marketing of food and beverage products made in Ghana "Please indicate your level of agreement or otherwise with the above statement.

□ Agree extremely □ Agree fairly □ Indifferent □Disagree fairly□Disagree extremely

(C) Perception or opinion of locally packaged food and beverage products in Ghana

(i)The standard/quality of **packaging of most** food products made in Ghana is

□ Excellent □ Good □ Satisfactory □ Poor

(ii) Food and beverage products **made in** Ghana are comparatively **less competitive** on the **local** market. Please indicate your level of agreement or otherwise

□Agree extremely □ Agree fairly □ Indifferent □Disagree fairly□ Disagree extremely

(iii) What rating would you assign to **locally manufactured/designed** food and food product packages as **against foreign** ones? Local packaging is

□ Superior □ Very Comparable □ Slightly Comparable □ Inferior

Please turn over

(iv) If **you agree with the** above perception or assertion (C, ii) , indicate the **three most common deficiencies** in the **packaging** of most locally manufactured food and beverage products. (Indicate using 1,2 and 3 only in order of priority/precedence)

□ Legibility of information on package (How readable)

□ Quality of material (paper, plastic, glass, metal, etc)

□ Artistic appeal of graphic design (How aesthetic)

□ Durability and/or quality of print out on package (fading, bleaching, faint etc)

□ Quality of secondary package (boxes, cartons, stretch-wrap, polybags , etc)

□ Containment design of package (Shape, form, size or style of package)

□ Closure or seal quality □ Other (please indicate)……………………………….

(D) Packaging Materials and Sources

(i)Please indicate the type of material used in the packaging of your products?

□ Glass □ Paper □ Plastics □ Metal □ Other(please specify)…………….……….…

(ii)Please indicate using 1,2 and 3 only in **order of precedence** ,which of the following influences your choice of packaging material and/or design.

□ Cost of production □ Availability of packaging material □ Environmental friendliness □ Personnel or spare parts for maintenance of machinery □ Availability of packaging technology □Market share for products with such packaging material/design

□ Other (please specify)…...

(iii)Please indicate the source of packaging materials/designs for your products.

□ Ghana………………..□ Africa…………………..□ Outside Africa……………...…

(iv) Please indicate two (2) of your peculiar challenges as a manufacturer of food and beverage products packaged in Ghana.

1…………………………………………………………………………………………

2……………………………………………………………………………………...

(v) Please give two(2) recommendations that could help improve the standard of the packaging of food and food products' industry in Ghana.

1…………………………………………………………………………………….....

2……………………………………………………………………………………..

☺ **Thank you very much** ☺

FORM A4

This questionnaire seeks to gather information on the **familiarity** of various food package manufacturers in Ghana with the **packaging of most food and beverage products made in Ghana**. It also seeks to know the corporate **opinion** of the **status** of packaging of most food and beverage products made in Ghana. (**Confidentiality is assured**).

NB: Please check (√) or fill boxes with numbers(1,2,3…) to indicate order of preference/precedence or fill blank spaces where applicable

(i) Name of Institution or Agency:…………………………………………………

(ii) Please check the ownership of the institution

□ Private □ Government □ Private and Government □ Other(please specify)…

(iii)Type of Institution or Agency

□ Regulatory □ Package Manufacture (Converters) □ Food Manufacturer (Users)

□ Research □ Policy/Business Advocacy □ Other(please indicate)….………

(iv) Contact Address:……………………………………………………………………

(v) Office Phone Nos :…………………………………………………………………

Location:………………………………E-mail/Website:………..…………………………...

(B) Familiarity with the Food Packaging Industry

(i)Are you familiar with the issues of packaging of food and beverage products in the world or African market (drinks, confectionery, fish, meat, dairy products ,etc) ?

□ Yes(very familiar) □ No □ Yes(somehow familiar)

(ii)Are you familiar with the packaging of most food and beverage products made in Ghana?

□Yes (very familiar) □ No □ Yes (somehow familiar)

(iii) "Effective /efficient packaging is necessary in the development and marketing of food and beverage products made in Ghana ".Please indicate your level of agreement or otherwise with the above statement.

□ Agree extremely □ Agree fairly □ Indifferent □Disagree fairly□Disagree extremely

(C) Perception or opinion of locally packaged food and beverage products in Ghana

(i)The standard/quality of **packaging of most** food products made in Ghana is

□ Excellent □ Good □ Satisfactory □ Poor

(ii) Food and beverage products **made in** Ghana are comparatively **less competitive** on the **local** market because of packaging. Please indicate your level of agreement or otherwise

□Agree extremely □ Agree fairly □ Indifferent □Disagree fairly□ Disagree extremely

(iii) What rating would you assign to **locally manufactured/designed** food and food product packages as **against foreign** ones? Local packaging is

□ Superior □ Very Comparable □ Slightly Comparable □ Inferior

(iv) If **you agree with the** above perception or assertion (C, ii) , indicate the **three most common deficiencies** in the **packaging** of most locally manufactured food and beverage products. (Indicate using 1,2 and 3 only in order of priority/precedence)

□ Legibility of information on package (How readable)

□ Quality of material (paper, plastic, glass, metal, etc)

□ Artistic appeal of graphic design (How aesthetic)

□ Durability and/or quality of print out on package (fading, bleaching, faint etc)

□ Quality of secondary package (boxes, cartons, stretch-wrap, polybags , etc)

Please turn over

□ Containment design of package (Shape, form, size   or style of package)

□ Closure or seal quality   □ Other (please indicate)…………………………..

(D) Product Line and Sources

(i)Please check which of these is included your product range?

□ Primary packages (direct contact with product)   □   Secondary packages

□ Tertiary packages □ Other (please specify)…...………………………………….

(ii) What type of material is used in the manufacture of your packaging products?

□ Glass □ Paper □ Plastics □ Metal   □ Other(please specify)…….…………..…

(iii) Please indicate using 1,2 and 3 only in **order of precedence** ,which of the following influences your choice of packaging material and/or design.

□ Cost of production □Availability of packaging material □ Environmental friendliness □ Personnel or spare parts for maintenance of machinery □ Availability of packaging technology □Availability of market for packaging products □Other(please specify)…….

(iv)Where do you obtain your inputs of production (graphic design, printing, cutting, moulding, closures, etc), that is raw or semi-processed packaging materials for production or sale? Please specify

□ Ghana………………..□ Africa………………….□ Outside Africa……………..…

(v)Please indicate two(2) of your peculiar challenges as a manufacturer of packaging materials in Ghana especially for food and food products.

1………………………………………………………………………………………

2……………………………………………………………………………………...

(vi) Please give two(2) recommendations that could help improve the standard of the packaging industry in Ghana.

1……………………………………………………………………………………………......

2………………………………………………………………………………………………..

(vii)Please list five (5) of your key clients (food and beverage products industry) in your service delivery.

1.………………………………………………………………………………………………

2………………………………………………………………………………………………..

☺ **Thank you very much** ☺

SENSORY EVALUATION FORM B1

Product: Orange Drink

Gender ◻ Male ◻ Female

Age Group ◻ Below 18 ◻ 18-25 ◻ 26-40 ◻ Above 40

Instruction: Please indicate your **level of preference** for each of the products served.

<u>Taste</u>

Sample Codes:

253	426	391
____ Like Extremely	____ Like Extremely	____ Like Extremely
____ Like Very Much	____ Like Very Much	____ Like Very Much
____ Like Moderately	____ Like Moderately	____ Like Moderately
____ Like Slightly	____ Like Slightly	____ Like Slightly
____ Neither Like nor Dislike	____ Neither Like nor Dislike	____ Neither Like nor Dislike
____ Dislike Slightly	____ Dislike Slightly	____ Dislike Slightly
____ Dislike Moderately	____ Dislike Moderately	____ Dislike Moderately
____ Dislike Very Much	____ Dislike Very Much	____ Dislike Very Much
____ Dislike Extremely	____ Dislike Extremely	____ Dislike Extremely

<u>Texture</u>

Samples:

____ Like Extremely	____ Like Extremely	____ Like Extremely
____ Like Very Much	____ Like Very Much	____ Like Very Much
____ Like Moderately	____ Like Moderately	____ Like Moderately
____ Like Slightly	____ Like Slightly	____ Like Slightly
____ Neither Like nor Dislike	____ Neither Like nor Dislike	____ Neither Like nor Dislike
____ Dislike Slightly	____ Dislike Slightly	____ Dislike Slightly
____ Dislike Moderately	____ Dislike Moderately	____ Dislike Moderately
____ Dislike Very Much	____ Dislike Very Much	____ Dislike Very Much
____ Dislike Extremely	____ Dislike Extremely	____ Dislike Extremely

Colour

Samples :

____ Like Extremely	____ Like Extremely	____ Like Extremely
____ Like Very Much	____ Like Very Much	____ Like Very Much
____ Like Moderately	____ Like Moderately	____ Like Moderately
____ Like Slightly	____ Like Slightly	____ Like Slightly
____ Neither Like nor Dislike	____ Neither Like nor Dislike	____ Neither Like nor Dislike
____ Dislike Slightly	____ Dislike Slightly	____ Dislike Slightly
____ Dislike Moderately	____ Dislike Moderately	____ Dislike Moderately
____ Dislike Very Much	____ Dislike Very Much	____ Dislike Very Much
____ Dislike Extremely	____ Dislike Extremely	____ Dislike Extremely

Overall Best Preference: Sample……………………

SENSORY EVALUATION FORM B2

Product: Orange Drink

Gender ◻ Male ◻ Female

Age Group ◻ Below 18 ◻ 18-25 ◻ 26-40 ◻ Above 40

Instruction:

Please indicate which of the two samples presented **tastes more like** a natural orange drink.

Sample Code

431 ◻

673 ◻

Why? Please choose only two (2).

◻ Sweetness ◻ Colour ◻ Texture (viscosity)

◻ Acidity ◻ Bitter aftertaste ◻ Flavour

SENSORY EVALUATION FORM B3

Preamble: You have been presented with three(3) samples of orange drink , two(2) of these are identical, and the third is different.

Product: Orange Drink

Gender □ Male □ Female

Age Group □ Below 18 □ 18-25 □ 26-40 □ Above 40

Instruction:

Please check or indicate the two(2) samples you perceive to be **identical** in the following sensory attributes.(Note the order of presentation of the **sample codes on this form** are different for each sensory attribute; FLAVOUR AND TEXTURE)

Batch I

FLAVOUR (Taste and Aroma)

Sample Code	Check Identical Samples
314	□
567	□
215	□

TEXTURE (Viscosity)

Sample Code	Check Identical Samples
912	□
467	□
677	□

Conclusion: Sample ………….and ……………….. are identical.

Batch II

FLAVOUR (Taste and Aroma)

Sample Code	Check Identical Samples
692	□
875	□
119	□

TEXTURE (Viscosity)

Sample Code	Check Identical Samples
294	□
661	□
045	□

Conclusion: Sample ………….and ……………….. are identical.

Batch III

FLAVOUR(Taste and Aroma)

Sample Code	Check Identical Samples
404	□
318	□
553	□

TEXTURE(Viscousity)

Sample Code	Check Identical Samples
913	□
428	□
607	□

Conclusion: Sample ………….and ……………….. are identical.

SENSORY EVALUATION FORM C1

Product: Newly Packaged Orange Drink

Gender □ Male □ Female

Age Group □ Below 18 □ 18-25 □ 26-40 □ Above 40

Instruction: Please visually inspect the exhibit of an orange drink product packaged in two different packaging designs. Please indicate your **response** by checking the boxes or filling the spaces provided.

Product Awareness:

1. How well do you know the orange drink product (Fresh Taste) you have been served with?

   □ Seen it before □ Heard about it □ Tasted/Consumed it before □ Other…..…

2. Have you consumed/tasted Fresh Taste before? □ Yes □ No
3. If yes, what is your opinion of the product?

Taste

□ Pleasant □ Sour/acidic □ Sugary/sweet □ Bitter □ Other………………….

Colour

□ Pale □ Appealing but not orange-like □ Orange-like □ Not appealing

Aroma

□ Odourless □ Orange-like □ Fruity □ Other…………………………………

Texture/Mouth feel

□ Juicy/Turbid □ Light/clear □ Slimy □ Astringent (unripe banana)

Acceptance of Primary Package

4. Please indicate your level of **acceptance or opinion** of **package A (sachet)** of Fresh Taste.

□ Poor □ Satisfactory □ Good □ Very Good □ Excellent

5. Please indicate your level of **acceptance or opinion** of **package B (labelled bottle)** of Fresh Taste.

□ Poor □ Satisfactory □ Good □ Very Good □ Excellent

6. **Package B (labelled bottle),** the alternative package for Fresh Taste comes with an **increase in price** of the product. Which of the following **prices would you** consider to be a **fair/appropriate price change (Package A to B) for the same volume?**

□ ¢ 1000 to 5000 □ ¢1000 to 4,000 □ ¢1,000 to 3000 □ Other ……………

7. Indicate the three **most obvious deficiencies** of **package A** if any. (Please indicate using 1, 2 and 3 in order of precedence)

□ Legibility of information on package (How readable)

□ Quality of material □ Closure or seal quality □ Handling is less convenient

□ Artistic appeal of graphic design (How aesthetic)

□ Durability and/or quality of print out on package (fading, bleaching, faint etc)

□ Containment design of package (Shape, form, size or style of package)

□ Other (please indicate)……………………………………………………..