THE IMPACT OF INTERNAL MARKETING ON CUSTOMER SERVICE EMPLOYEES: THE CASE OF MOBILE TELECOM NETWORK (MTN).

BY

WILSON EDZORNA DZISAH
(B Ed. SOCIAL SCIENCES. UCC, GHANA)

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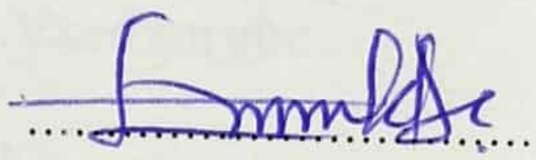
MASTERS OF BUSINESS ADMINISTRATION
(MARKETING OPTION)

JUNE, 2008

DECLARATION

I Wilson Edzorna Dzisah, hereby declare that this dissertation is the result of my own research.

I further declare that the work in this thesis for the degree of Master of Business Administration in Marketing has not been presented wholly or in part for any degree. References cited in this work have been duly acknowledged.



Wilson Edzorna Dzisah

Candidate

Samuel Y. Akomea (Mr.)

Supervisor

Head of Department

28/4/09

DEDICATION

I dedicate this research work to my beloved father William Korku Dzisah for his invaluable contributions to my education, guidance and tenacity since my mum expired.

This work is also dedicated with a heavy heart to the ever cherished memory of my beloved mother, Vincentia Aku Dzisah, and my uncle, mentor and friend Bernard Vordzorgbe.

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ABSTRACT

This research uses a grounded theory approach at identifying the variables affecting the motivation of customer service employees of MTN, Ghana. The research questions ask whether there is a variation in the motivational factors based on gender and age. And also whether the variables affecting the motivation of part-time employees differ from that of full-time employees? The literature review, apart from summarizing the modern approaches to motivation theories, shows that these research questions are also important in understanding the recruitment and selection procedures of MTN. Data was triangulated from three sources: questionnaires, one-to-one interviews and a past conducted survey from MTN. The findings from these data showed that men wanted growth in terms of job promotion. Having a clear progression plan was important to them. Women and part time employees seemed to be intrinsically motivated and time flexibility was an important concern to them. No clear differences were found across the employees of different ages. And finally, it was concluded that MTN has to rethink on how it uses its communication channels and make sure that the employees feel they are a part of the organization. This suggestion becomes especially important in the narrow context of the call centre work as explained in this paper.

Based on these findings, this study concludes that consumer behaviour is driven by a complex set of factors so it cannot be simply predicted on the basis of popular attitudes amongst consumers, and sets out some implications of these findings for marketers.

CHAPTER ONE

INTRODUCTION

1.0 BACKGROUND TO THE STUDY

The gradual integration of the world's markets through the extensive intrusion of information and communication technology has been hailed the world over to be the best developments of this age. However, this new world order has brought on its trail competition, which has been threatening the survival of businesses, employment, capital formulation and economic stability. To gain competitive advantage in this competitively globalized market demands a greater effort at customer acqusition, retention and long-lasting relationships through efficient customer service. Thus, to enhance the performance of the customer service employees' demands the identification of variables that motivates them. This growing need to develop and improve the link between the firm and its external customers makes up the case for internal marketing (the motivational aspect) - a management philosophy of treating employees as customers. This concept is not to be overlooked if a higher market share and growth is to be achieved through the use of customer service.

Companies were chastised by Kotler (2000) not to only ask "How can we reach our customers? But also how can we find ways to let our customers reach us?" In this light, the effectiveness and efficiency of customer service employees' holds the key. The customer service function is viewed as the key to unlock the door of corporate success. Most service firms are in the buyer market, where the customer has a vast range of alternatives to choose from and would only remain loyal if he is accorded attention, respect and recognition.

Internal marketing to Kotler (2006) requires that everyone in the organization accepts the concepts and goals of marketing and engage in choosing, providing, and communicating customer value. He points out the fact that everything the service provider does for its external customers is first perceived and evaluated by its own personnel.

The increasing importance of internal marketing as a means of delivering an effective customer service is derived from the fact that a firm's employees are its internal customers among which are the customer service employees (Parasuraman, 1993). Customer service employees' interaction with the external customers must make a customer satisfied in order to build a loyal customer base which could be catapulted into a long lasting relationship. This relationship, if nurtured, would result in expansion and growth of the company. Kotler (2006) summarized this as "only when all employees realize that their jobs are to create, serve, and satisfy customers does the company becomes an effective marketer"

It is imperative to consider internal marketing seriously as the best way to rendering efficient customer service. From the above exposition, it is necessary to market the core competencies or commodities to the internal market-employees so as to have every employee to be a well informed staff that can link up with the external customer effectively

Internal marketing is a two-type management process, attitude management and communications management. This work is set out to look at the attitude management. That is, attitude of employees and their motivation for customer-consciousness and service-mindedness (Gronroos, 2007 p. 387).

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Internal marketing in this context refers to the motivational factors that drive the customer service of any firm to be competitively effective and efficient in today's global village. The new interest in internal marketing among reseachers has revitalized the concept from a relationship-oriented and network organization-based perspective which Gronroos (2007) believed has brought new aspects to the management of human resources: 'a need to view individuals on the internal markets as a relationship partners and a need to create internal marketing pocesses that do not only include the personnel of one organization but reach out to people in relationship with other organizations in the network'.

The concept of internal marketing thus operates as a holistic management process to integrate multiple functions of the firm in two ways. First, it ensures that employees at all levels in the firm (including management) understand and experience the business and its various activities, campaigns and processes in the context of an environment that supports customer consciousness. Second, it ensures that all employees are prepared and motivated to act in a service-oriented manner (Gronroos, 2007 pp. 386). The premise of internal marketing is that internal relationships between the organization and its employee groups must operate effectively before the firm can be successful in achieving its goals regarding its external markets.

In this context internal marketing (identification of motivational factors) has been posited as one of the major determinants of increased external market orientation (Piercy 1995) and business performance (Heskett et al 1994). As such, there is a need to examine the impact of internal marketing on customer service employees.

The question 'how individuals relate to the group and organisations in which they are participants' lies at the heart of our understanding of human relations within organisations (Brown 2001, p.114 cited in Whittle, 2005 p. 1302). Understanding motivation is important at three levels. First for management, who clearly needs to know and understand what motivates people. From the managerial perspective, it is hoped that employees will act in the best interests of the organisation not because they are coerced, threatened or rewarded, but rather because they are motivated by a strong identification with company goals and values (Kunda 1992; Willmott 1993, cited in Whittle 2005). Second, employees need to think through what expectations they have of work and whether they are happy with their lot. Third, for personnel and development professionals, an understanding of motivation is essential in order to comprehend fully the effects of variations in other factors, leadership style, job redesign and salary structure, as they relate to performance and satisfaction (Greenberg and Baron, 1995; Steers and Porter, 1991).

It needs to be stated that motivation may change with changes in personnel, social, economic and other factors as shown by a number of survey results and it may not be the same for every sub-group (Wiley, 1997). More importantly, management must understand what motivates employees within the context of the role they perform (Kovach, 1987) given the restricted nature of most work settings (Wegge et al., 2006).

The consumer, it has been established is the king at the marketplace and should be treated as such to ensure business success. This is necessary because human as the consumer is, cannot be easily predicted. Literature in this area of attitude and behaviour produced strong evidence that there is pronounced incongruence between consumer attitudes and consumer behaviour. Wong et al. refer to this as an "attitude-behaviour

gap" or a "words-deeds inconsistency" (Wong et. al. 1996: 264 cited in Wegge et al., 2006). This assertion has exacerbated the burden on customer service employees, often termed the front desk, which drives and positions a firm firmly in the minds of the consumer.

Customer service is generally viewed to be problematic from a marketing management and quality management perspective (Christopher et al. 1991). It is therefore, paramount to consider the view that motivational aspect of internal marketing is needed by the customer service employees to function effectively.

1.1 STATEMENT OF THE PROBLEM

The customer service employees of the leading cellular phone operator in Ghana, MTN who were highly commended for the corporate success of Areeba in 2006 has come under much media criticism lately on the Ghanaian liberalised airwaves for their perceived pathetic and appalling customer service delivery (Source: myjoyonline.com, November 12, 2007).

The intense competition in the telecommunication industry has brought intense pressure on the customer service performance as one main area of competitive advantage (Parasuraman et al, 1985). With the frequent challenges of the performance of the service in terms network failures in Ghana, it is believed the only way to maintain the customer base is through effective customer service. Thus, internal marketing has assumed an important role in ensuring the survival of any service based organisation through institutionalization of effective motivational schemes.

The creation of MTN's Groups customer-centric focus, continuous examination and the attempt to improve its call centre response rates across all operations coupled with the worsening staff turnover rate which has reached a level above 9 per cent exceeding the targeted rate of 5 to 7 per cent. This perceived unexpected downturn in service delivery and the continued increase in labour turnover after the takeover by MTN have given the cause to suspect the motivational concerns of its customer service employees. Source:www.mtn.com/Sustainability/SocialResponsibility.aspx)

This dwindling performance in the set rates was exacerbated by a marginal decline in the average net acquisition rate of 488, 000 subscribers a month in the past year to a figure hovering around 460,000 with which the prepaid subscribers comprising 94% of the subscriber base. (Source:www.mtn.com/Media/overviewdetail.aspx?pk=.)

It seems the ever increasing levels of adverstisements, merchandising, and sponsorship is surreptitious attempt to make up for the shortfalls resulting from the inability of the customer service to hold on to some of their subscribers. However, the inability to improve upon the customer retention rate despite all the marketing efforts cannot be easily understood. This seemingly contradiction in efforts and worsening attrition rate has occasioned the need to examine its customer service employee's attitude to find out the motivational variables that affect them.

1.2 AIMS AND RESEARCH OBJECTIVES

The objective of this study is to probe deeply for the influence of internal marketing's motivational variables on customer service employees and to analyze this multifarious phenomena that constitute the life cycle of the customer service unit with a view of

coming out with findings which will be beneficial to establishments that has a customer service units.

This study is primarily set out to identify the internal marketing variables which motivate the technical support, sales and marketing employees of MTN, the leading cellular phone operator in Ghana.

This work is to also find out what employees consider necessary to be included in their internal marketing (motivational) package, which in turn will tell us a lot about the culture of the company. This will provide an explanation for the attrition rate and help us understand the implications of the company's reward structure and pay system in order to better its customer service.

1.3 RESEARCH QUESTIONS

The research questions are derived from the Hilltrop (1999) suggestions that he offers in his article 'How can Organisations Attract and Keep Talent?'

- How varied are motivational factors of MTN' internal marketing based on gender and age?
- What are MTN's part-time employees looking for in terms of the duration of their career/job?
- Do all employees feel that they have less growth opportunities?

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1.4 SIGNIFICANCE OF THE STUDY

This research should be seen as a preliminary attempt at addressing an issue with important implications for both services marketing theory and practice. This study will serve as a guide to the corporate bodies and institutions that most importantly are service oriented. It will also be of great concern to governmental agencies and Non-Governmental Organisationals which are human centred as well as the respective ministries, metropolitan, municipal and district assemblies responsible for policy formulation especially the labour laws and the overall service sector policies.

Evans (2005) supports the academic applicability of this study as the research agenda is logically developed from the surrounding academic literature and "the synthesis of different, apparently unconnected pieces of information" (Evans (2005) p.17) taken from a variety of existing studies. The solid basis of this study in the literature with a clear, original research agenda means that the researcher was able to avoid becoming a "new Columbus- forever discovering old truths" (Phillips (1976) p.11), meaning that this study is applicable to the cumulative process of increasing human knowledge (McNeill (1990)).

The study shall provide new insights to the cellular phone operators on key issues and options for mitigating any negative impacts of the motivational aspects of their internal marketing on their customer service delivery. Thus, the researcher considers this work as his modest contribution to academic knowledge for marketing practice. It my fervent hope and believe that this work would help inform management and other stakeholders on the customer service employees' needs and options for packaging and delivering corporate strategies to their internal customers for an efficient influence on the external customer environment.

This study is fashioned to understand the impact of internal marketing on customer service which is the link to the external customers hence relationship, retention, loyalty and sustenance of the market share. It is therefore, to provide the impetus to internally market the competencies of the company and to make marketing to permeate the entire organization with every employee having the feeling to belong.

Understanding the elements of the attitude aspect of internal marketing specifically motivational measures that impact customer service employee attitude will create the opportunity for taking the right decisions to win and retain the good employees and ultimately loyal customers.

1.6 ORGANIZATION OF THE STUDY

This work is arranged in five chapters: Chapter one constitutes the introduction. It highlights on the background to this study, a brief on the selected case of study, the problem statement, the aims and the objectives of the study. It also contains the research questions, the justification of the study, the significance and how the work is organized.

The second chapter deals with the reviewed literature. This is mostly other findings and contributions made on related works relevant to this study. It serves as secondary material from which variables used as the focus for this study are all unearthed.

Chapter three gives an in-depth profile of how the work is carried out. This chapter captioned 'methodology' laid out all issues concerned with the methods adopted in conducting the study.

The fourth chapter deals with presentation of data and analysis. It contains the presentation of the processed data through the use of the relevant statistical tools. The data presented is analyzed to give them meaning and relevance.

Chapter five gives an overview of the findings conclusion of the study together with recommendations. It also contains the references of other works used, bibliography and appendices relating to the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

Internal marketing has become an important aspect of marketing in service firms due purely to the ever present competition in the services sector which is the leading sector of the world's greatest economies today. This situation has positioned the customer service as the engine of the service firms.

The attitude management aspect of internal marketing is purely dependent on the motivational aspects of employees. Researchers utilizing service blueprint and internal marketing schematics have concluded that satisfied internal customers are more likely to achieve successful exchanges with both internal and external customers (Lings 1999; Lings and Brooks 1998). When the organization fosters a satisfied workforce through internal marketing, the conditions should lead to greater service-type behaviours between entire work groups. Research pertaining to Total Quality Management further substantiates the importance of employee satisfaction in the creation of a customer-oriented workplace (Curkovic et al. 2000).

2.1 THEORETICAL FRAMEWORK

The most prominent contributions in this area of study can be seen in the analysis of the service triangle, and the SERQUAL and gap model which are geared towards improving services. The service triangle according Zeithaml suggests that there are three types of marketing that must be successfully carried out for a service organization to succeed. To him, all of these relate to making and keeping promises to customers. The triangle consists of external marketing efforts on the right side; interactive

marketing at the bottom and the left side is internal marketing which enables employees to keep promises that have been made to the customers.

2.2 THE SERVICE TRIANGLE, SERVQUAL, AND THE GAP MODEL'S LINKAGE OF CUSTOMER SERVICE AND INTERNAL MARKETING

The concept of internal marketing has been discussed in the academic literature for over two decades (Piercy and Morgan 1990, 1991). Surprisingly there is still no clear consensus as to the nature of its construct and what its implementation entails As a result there is no empirical evidence linking internal marketing implementation with customer service outcomes, despite the strength of the conceptual arguments in support of the benefits of internal marketing. There is however, increasing evidence on the positive impact of customer service on organisational performance. (Rafiq and Ahmed 1993; Varey 1995).

Internal marketing refers to the activities the firm must carry out to train, motivate, and reward its employees. Zeithaml and Bitner (2000) believed that unless service employees are able and willing to deliver on the promises made, the firm will not be successful in keeping its promises and the services marketing triangle will collapse. This contribution of Zeithaml suggest the vital role that customer service plays in fulfilling the promises of their firms in order to maintain the service delivery satisfactory if not a perfection. This goes down with Gronroos (2007) who opined that the many people representing the firm influence the customer perception of quality and value creation in various service processes. These people are believed to be involved in marketing to the extent that Gummensson (1999) referred to these customer contact service employees as part-time marketers.

To ensure that the customer service stay focus and deliver they must have the best of knowledge about the service. To promote good service knowledge, attention must be paid to attitudes, that is, changing negative or attitudes that are indifferent by improving upon employees' knowledge which are according Gronroos (2007) intertwined. Internal marketing activities involves the training of employees on all levels from top management through to contact personnel in understanding their role in the total relationship with customers and each and everyone's role and tasks in maintaining and enhancing this relationship.

Internal marketing is based on the assumption that employee satisfaction and customer satisfaction are intrinsically linked which has led Lings and Greenley (2005) to suggest encouraging employees, respecting them and acknowledging the good performances, correcting them, and advising them for the challenges ahead in a socially conducive manner.

In his research Ballantyne D (in Lovelock and Gummenson, 2004) viewed internal marketing as a knowledge renewal concept where groups of customer contact employees have accumulated knowledge about customers' behaviour and preferences as well as about how and with what means to best serve customers and create a good service quality perception.

In the area of empowerment, Bowen and Lawyer (1992) claimed empowering employees means providing them with information about the performance of the organization, rewarding them based on the organization's performance, creating a knowledge base that makes it possible for employees do understand and contribute to

the performance of the organization, and giving employees the power to make decisions that influence organizational directions and performance.

Internal marketing according to Lings (2002) and Keller (2002) is the same as to treat employees' as internal customers. Internal marketing facilitate employees to be more customer oriented and service centred (Donaldson and O'Toole, 2002). The scholars regarded internal marketing as quasi human resource management (Joseph, 1996; George and Grönroos, 1989) that seems to manage human resource in the perspective of marketing (Bansal et al., 2001).

It is worthy to note that the quality of a service has been studied in the area of business management for years because the market is more competitive and marketing management has transferred its focus from internal performance such as production to external interests such as satisfaction and customers' perception of service quality.

Base on this intricate issue of service quality, Parasuraman, Zeithaml and Berry (1985) developed the "Gap Model" of perceived service quality. In this model has five distinct identified gaps. The first gap covers areas like marketing research orientation, upward communication and the levels of management within the organisation simply referred to as consumer expectation – management perception gap.

The second gap concerns with management perception – service quality specification gap which deals with management commitment to service quality, goal setting and standardization of tasks as well as the perception of feasibility. The third, service quality specifications – service delivery gap covers broad areas that obviously concern customer service employees. These are teamwork, employee-job-fit, technology-job-fit, perception control, supervisory control systems, and role conflict and role ambiguity.

The fourth identified gap, service delivery – external communication gap results from the horizontal communication channels within the firm and the propensity to overpromise customers.

The above gaps converged to form the fifth, expected service – experience service which is purely a matter of service quality (Zeithaml et al, 1988, P. 46). These expositions showcase how service quality depends on a gamut of factors, not just the end result. It is in this light that this work sought to delve deeper into what excites the customer service employees of MTN to deliver value and to fulfil the promises made to their external customers.

Another construct to solve the myth surrounding the service delivery and expectations is the SERVQUAL model. SERVQUAL model was originally measured on ten aspects of service quality: reliability, responsiveness, competence, access, courtesy, communication, credibility, security, understanding or knowing the customer and tangibles. This model just as the fifth gap in the gap model helps in the attempt to measures the gap between customer expectations and experience. However, by the early nineties the authors had refined the model to the useful acronym RATER: Reliability, Assurance, Tangibles, Empathy, and Responsiveness (Parasuraman et al.'s 1985)

SERVQUAL has its detractors and is considered overly complex, subjective and statistically unreliable. The simplified RATER model however is a simple and useful model for qualitatively exploring and assessing customers' service experiences and has been used widely by service delivery organizations. It is an efficient model in helping

an organization shape up its efforts in bridging the gap between perceived and expected service.

This is the situation with MTN's customer service employees who are constantly at the receiving end of a flop in service quality or failure to fulfil the promises to the external customers. In all these situations these service personnel are expected to rise up, to cushion the service quality gap, fully prepared and motivated.

Maslow (1954) sought to explain why people are driven by particular needs at particular times. His answer is that human needs are arranged in a hierarchy, from the most pressing to the least pressing. In order of importance, they are physiological needs, safety needs, social needs, esteem needs, and self-actualization needs. With the increase in the number of knowledge workers, employees today would most likely be inclined to develop and exploit their own potential unconditionally (Kalra, 1997).

Base on Maslow's hierarchy of needs theory, Tampoe (1993) found that the biggest motivational factor for knowledge workers is "personal growth" followed by "operational autonomy" and then by "task achievement". Among the four major motivators, money was the least motivational factor

2.3 MOTIVATIONAL THEORETICAL DIMENSIONS

Research on motivation is concern basically with the question, "what creates human action" (Franken 1994, cited by Ahl 2006, p. 387). Motivation has been defined as the set of processes that arouse, direct and maintain human behaviour towards attaining a goal (Greenberg and baron 1995). This definition along with all the other definitions provided by social scientists like Atkinson (1994), and Campbell and Pritchard (1976)

(all cited by Steers and Porter, 1991) have three common elements which should be primarily concerned with. These are:

- What energizes human behaviour?
- What directs or channel such behaviour?
- How this behaviour is maintained or sustained? (Steers and Porters 1991, p.6)

The above three distinct areas of concern although very core to research works on motivation, hold firm only on certain basic assumptions. The three basic assumptions that guide contemporary research on human motivation are as follows:

- Motivation is inferred from a systematic analysis of how personal, task and environmental characteristics influence behaviour and job performance.
- As stated in the introduction, motivation is not a fixed trait. It refers to a dynamic internal state resulting from the influence of personal and situational factors. As such, motivation may change with changes in personal, social or other factors.
- Motivation affects behaviour, rather than performance (Nicholson 1995, p. 330-1). Initiatives designed to enhance job performance by increasing employee motivation may not be successful if there is a weak link between job performance and an employee's efforts. (Wiley 1997, p. 263).

Motivational concepts abound, as such, it is relevant to begin with a general heuristics framework upon which diverse motivational approaches are mapped and shown below:

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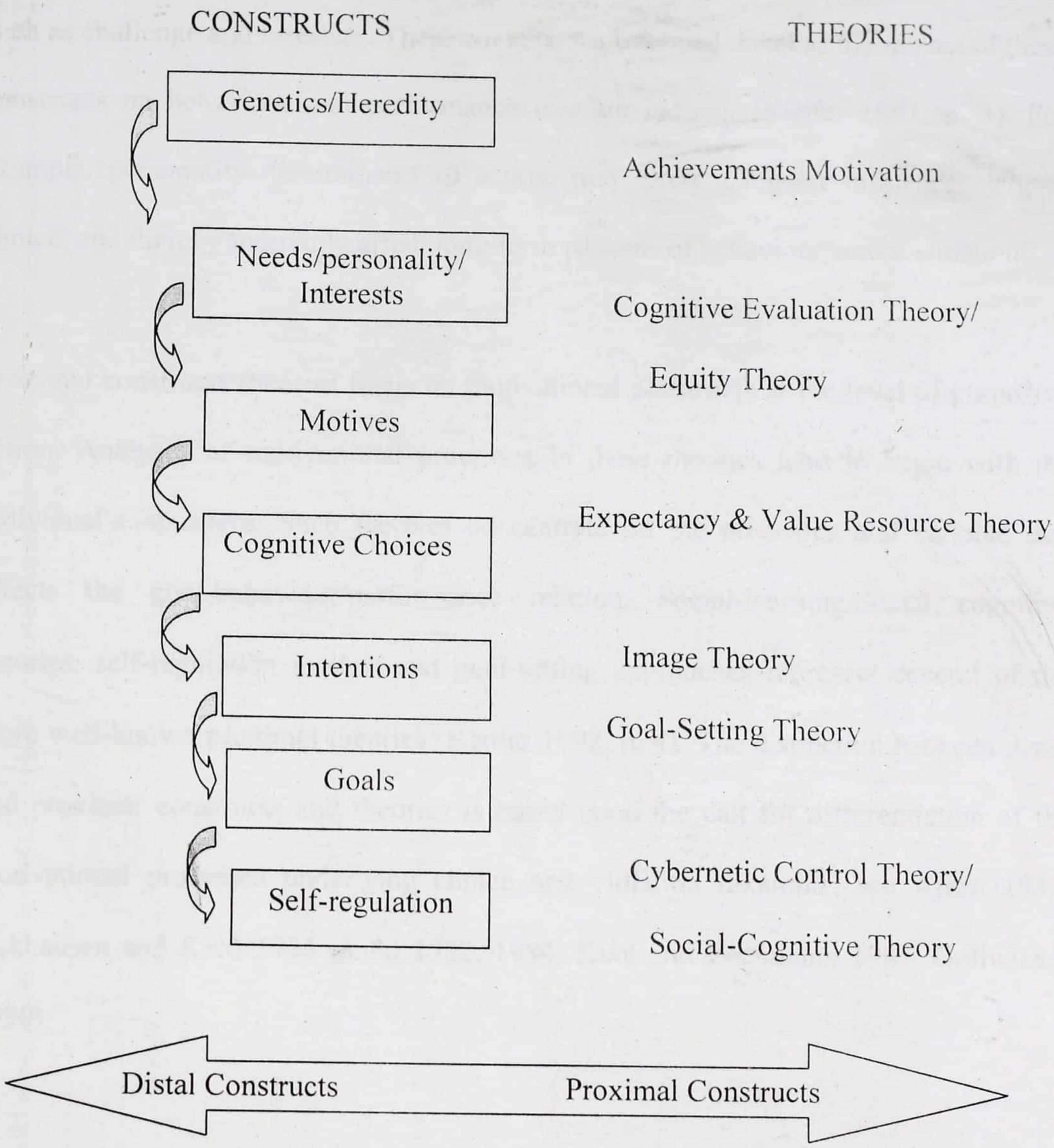
Figure 2.1



A heuristic framework of motivation constructs and exemplar motivation theories

Source: (Kanfer 1992, p. 4)

As implied, theories and their associated constructs can be organized in terms of their conceptual proximity to action. Theories of distal constructs, such as achievement motivation and expectancy-value, stress the impact of non-cognitive individual differences on choice. Other distal perspectives, such as cognitive evaluation theory and

organization justice theories, emphasize the influence of activation particular motives, such as challenge and injustice. These constructs are termed distal as the impact of these constructs on behaviour and performance is often indirect (Kanfer 1992, p. 3). For example, personality determinants of action, may exert a regular influence on goal choice, and thereby indirectly affect long-term patterns of behaviour across situations.

Proximal constructs theories focus on motivational constructs at the level of purposive action. Analyses of motivational processes in these theories tend to begin with the individual's objective. Such theories concentrate on the processes and variable that affects the goal-behaviour/performance relation. Social-learning/Social cognitive theories, self-regulation models and goal-setting approaches represent several of the more well-known proximal theories (Kanfer 1992, p. 4). The distinction between distal and proximal constructs and theories is based upon the call for differentiation of the motivational processes underlying choice and violation (example, see Ajzen 1985; Hckhausen and Kuhl 1984 (Kuhl 1982, 1984; Kuhl and Beckmann 1985; Gollwitzer, 1990).

The modern approaches to motivation had been organized into three related clusters (Kanfer 1992 cited by Wiley 1997) as follows:

- Goal/self-regulation perspectives;
- Cognitive choice/decision approaches, and
- Personality-based views. (Wiley 1997, p. 264).

Goal/self-regulation frameworks of work motivation emphasize the factors that influence goal striving which focuses on the relationship between goals and work behaviour (Locke and Latham 1990). The idea is that goal setting produces high performance. The basic premise of goal setting theory is that an employee's conscious

intentions (goals) are primary determinants of task related motivation since goals direct their thoughts and actions (Locke et al. 1988). Results of goal/self-regulation research indicate two critical preconditions of a positive goal-performance relationship: acceptance of the goal assignment and provisions for performance feedback.

More recently, cybernetic control (Stacey 2003), resource allocation (Kanfer and Ackerman 1989), and social cognitive theories (e.g. Bandura 1986) have been used to examine more closely how particular attributes of a goal, a person and a situation influence goal striving and performance (Nicholson 1995, p. 334). These findings suggest that task demands, self-efficacy, goal commitment, and task orientation are important determinants of the effectiveness of goal setting methods (Nicholson 1995, p. 334; Wiley 1997, p. 264).

Cognitive choice/decision approaches of work motivation emphasize two determinants of choice and action: expectations; and subjective valuations of the consequences associated with each alternative. These expectancy value (EV) theories are intended to predict an individual's choices or decisions. More integrative frameworks have been developed. They incorporate the classic assumptions of EV theories in a broader framework of decision making that includes individual differences in personality and other motivational processes, including self-regulation (Nicholson 1995, p. 332; Wiley 1997, p. 264).

Personality-based views emphasize the influence of enduring personal characteristics they affect goal choice and striving. One type of personality-based work motivation .perspective concerns models based on broad theories of personality, such as Abraham Maslow's Hierarchy of Needs Theory. Workplace behaviour is posited to be determined

a person's current need state in certain universal need categories. A second type of perspective considers the influence of a small set of psychological motives behaviour and performance. This perspective focuses on the role of individual differences in the strength of achievement motives (e.g. Clayton Aldefer's ERG theory, discussed below). Individuals with a high need for achievement are more likely to want and/or select challenging tasks. Other motive theories emphasized the conditions that arouse the motive and its influence on behaviour. For instance, in the Equity Theory primarily from J. Stacey Adams' work - the arousal of the justice motive occur when an employee perceives an imbalance in his/her inputs and outcomes relative to others' (Bowditch and Buono 1997, p. 89 and 103, cited by Nicholson 1995, p. 333; Wiley 1997, p. 264)

While these personality-based theories do not necessarily predict motivation, they can provide a basic understanding of what energizes (motivates) individuals. The main strength of Maslow's Hierarchy of Needs Theory is the identification of individual needs for the purpose of motivating behaviour. By appealing to an employee's unfulfilled needs, managers may influence performance. Aldermen's ERG Theory is one attempt to modify Maslow's hierarchy by reducing the number of need categories. Alderfer found only three levels of need (Wiley 1997, p. 265):

- existence or survival (E); relatedness (R),
- dealing with social interaction and the external facets of esteem (recognition and status from others); and
- growth (G), focusing on the desire to achieve and develop a person's potential and the internal facets of ego fulfilment (success and autonomy).

David McClelland's Socially Acquired Needs Theory proposes that people are influenced by a need for achievement, power, or affiliation and that the strength of that

particular need will vary according to the situation. Studies have found that employees with a high need for achievement will set higher goals than will those with lower achievement needs (Wiley 1997, p. 265). Another research-based theory is Herzberg's Motivator-Hygiene Theory. Herzberg's research suggested that motivation is composed of two largely unrelated dimensions:

(1) job-related factors which can prevent dissatisfaction, but do not promote employees' growth and development (hygiene); and

(2) job-related factors that encourage growth (motivators).

Even though there has been some support for Herzberg's thesis, most empirical studies refute predictions based on this theory. Needs for salary, recognition and responsibility, for example, have been shown to operate both as motivators and as hygiene factors (Maidani 1991). In general, the theories mentioned here continue to provide the foundation for a significant amount of organization and management development and raining, including work redesign and career development (Wiley 1997, p. 265).

2.4 MOTIVATIONAL FACTOR VARIANCES BASED ON SEX, AGE, AND PART/FULL TIMERS

A research conducted on a group of Australian women results show that nearly two thirds of women working full time would prefer to work part time but did not reduce their hours because part-time employment, as perceived by both full-time and part-time women, was associated with fewer promotion opportunities and perceptions of being less committed. Some of the women emphasized the value of flexibility which included variable start and finish times, being able to work from home and being able to change days when necessary (McDonald et al. 2006, p. 481). Measures such as flexible

employment and parental and maternity leave which facilitate career continuity are important. They would be expected to have an impact on the accumulation of women's human capital and wages as well as incentives to acquire skills before and after labour market entry (Joshi et al. 2007, p. 53).

Using data on women working part-time and full time in different level occupations in the *British Household Panel Survey*, a paper by Tracey Warren reveals a less positive picture of their 'life balancing' than is portrayed in much work-family literature as she examines the financial situations and the leisure lives of female part-timers in lower level jobs. They emerged as the least financially secure employees and less satisfied with their social lives too. She concludes by saying that to assess all the benefits and disadvantages associated with working part-time and with other work-life balancing strategies, it is important to examine how all life domains with each other since the work-life system is multi dimensional (Warren, 2004)

To date, relatively little attention has been given to understanding the effects of aging and adult development on work motivation (for exceptions, see Boerlijst, Raynor & Entin 1982; Warr 2001 cited by Kanfer and Ackerman 2004, p. 440). The research conducted by Warr et al. across four samples designed to be representative of the British population aged between 16 and 64, older persons reported lower career-related motivation, consistent with a reduced interest in some aspects of new learning. However, they concluded, by saying that although these in-general patterns are statistically significant, it is essential to recognize that associations with age are not strong and that around each average score there is considerable between-person variation (Warr et al. 2001). There is neither theoretical justification nor empirical evidence to support the notion of an inevitable and universal decline in work motivation

with age (Kanfer and Ackerman 2004, p. 455). There have been well-documented findings indicating a decline in fluid intellectual abilities (which deal with the learning of novel ideas over the life course) that have led many practitioners to conclude that this is the major factor responsible for putative declines in performance with age.

However, as Poffenberger suggested sixty years ago: It would be a safe estimate to say that one's maximal capacity in essential functions declines in the neighbourhood of 1 to 1.5 percent a year from the age of 25 years to the age of 50 to 55 years, with a more rapid fall in the later years.

It must be remembered, however, that the level of achievement that is attained at any age is much more likely to be a question of interest and incentive than of capacity (1942, p. 65 as cited by Kanfer and Ackerman 2004, p. 443). In her article titled 'What motivates employees according to over 40 years of motivation surveys', Carolyn Wiley explores past and present attitudes of employees concerning work-related motivational factors. She compares the results of four motivation surveys conducted in 1946, 1980, 1986 and 1992. During 1992 approximately 550 surveys were administered to persons employed in industries such as services, manufacturing, utilities, and health care and government agencies. The workers overwhelmingly selected "good wages" as the top motivator. Although, "good wages" seem to be purely extrinsic, they do communicate what the company values and affect employees' emotional and familial wellbeing

(Wiley 1997, p. 267)

Table 2.1

Factors	1946	1980	1986	1992
Full appreciation of work done	1	2	2	2
Feeling of 'being in on things'	2	3	3	9
Sympathetic help with personal problems	3	9	10	10
Job security	4	4	4	3
Good wages	5	5	5	1
Interesting work	6	1	1	5
Promotion and growth in the organization	7	6	6	4
Personal or company loyalty to employees	8	8	8	6
Good working conditions	9	7	7	7

Comparisons of employee responses in 1946, 1986 and 1992

Source: (Wiley 1997, p. 268)

Table 2 shows the 1992 survey results according to subgroups reporting higher positive significant preferences for each job factor. Since the difference between age group was not significant, it was concluded that good pay is an important motivator regardless of age (Wiley 1997, p. 273)

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Table 2.2

Factors	Employment status	Gender	Age
Full appreciation of work done			
Feeling of 'being in on things'		Women	
Sympathetic help with personal problems			
Job security			
Good wages			
Interesting work	Part-timers	Men	
Promotion and growth in the organization			
Personal or company loyalty to employees	Full-timers		
Good working conditions	Part-timers	Women	
Tactful discipline			

Table of job factor comparisons

Source: (Wiley 1997, p. 270)

2.5 MOTIVATION IN THE WORK ENVIRONMENT

The question is whether it would be possible to increase the motivating potential of work (e.g., task variety, task significance, task completeness) given the strongly restricted nature of the work setting in which the basic nature of the task itself cannot be changed. Previous research has shown that call centre agents responsible for outbound calls report less time pressure, more autonomy, and lower strain than agents working only inbound (e.g., Isic et al. 1999). Moreover, it can be expected that employees also value getting access to training and development programs (Shah and Sandi 2003; Wegge 2006, p. 68). Nevertheless, Wegge et al. (2006) were able to replicate in two

studies that strong relationships exist between organizations identification and several indicators of work motivation and wellbeing.

2.6 LINKS BETWEEN MOTIVATION, RECRUITMENT AND SELECTION

Recruitment is defined as the process of generating a pool of capable people to apply for employment to an organization. Selection is the process by which managers and others use specific instruments to choose from a pool of applicants a person or persons most likely to succeed in the job(s), given management goals and legal requirements (Bratton and Gold 2003, p. 221). The attraction and retention of employees are crucial to an employment relationship, based on a mutual and reciprocal understanding of expectations, as well as an attempt to predict how a potential employee might behave in the future and make a contribution to the organizations requirement (Newell and Shackleton 2000 cited by Bratton and Gold 2003, p. 222).

The overall approach taken will reflect an organization's strategy and philosophy towards the management of people (Bratton and Gold 2003, p. 243). Let's see how recruitment and selection fit in the strategic management of the organization.

Consider this: today's executive spends a great deal of time altering the content and processes of their business in order to enhance their results. That is, they focus on such things as goal setting, planning, and organizational structure (the content), as well as skills training and development and policy changes (the processes), in order to see their business improve. But by focusing exclusively on the "what" and "how" of business, they're limiting their progress. Sure, they may see some short term gains from their team, but when it comes to long-term progress, they fall miserably short, because true business results are produced by human behaviour. You might ask, "What does this have to do with hiring and firing people?" Quite simply, most people hire according to a

candidate's résumé. They look at the "what" (what the candidate did in the past) and the "how" (how the candidate accomplished the "what"). If those two factors look good, then the candidate gets the job. In general, the "what" and the "how" are not the best indicators for how someone will perform in your company. Good hiring is really about behavioural selection. That is, select people based on their behavioural tendencies, not on their resume (Schminke 2006, p. 21).

A major government survey (UK) carried out in 2002 asking over a million people how they found their current jobs (Labour Market trends 2002) revealed that informal channels account for a majority of new hires, with word-of-mouth recruitment topping the poll by a considerable margin which is shown in Table 1 (Taylor 2005, p.183).

Table 2.3

Recruitment (in percentages)	Men	Women
Hearing from someone who worked there	30	25
Reply to an advertisement	25	31
Direct application (e.g. walk in)	14	17
Private employment agency	10	10
Job centre	9	8
Other	12	9

(Labour market Trends, 2002 cited by Taylor 2005, p. 183)

Some research findings, such as those of Kirnan et al (1989), Blau (1990) and Iles and Robertson (1997), strongly suggest that informal recruitment methods yield a better selection of well-qualified applicants and also found a correlation between informal recruitment, low staff turnover, and high levels of subsequent employee performance.

The relatively low turnover rates are probably best explained by the likelihood that. informal recruits have more realistic perceptions of what the job will be like (Taylor 2005, p. 183).

One more reason for the apparent success is that the co-worker responsible for the referral will also have a reputational stake in the success of the person, whom he or she referred, providing an additional reason to provide assistance and support to the new hire (Baron J., and Kreps D. 1999, p. 342 cited by Taylor 2005, p. 184). Cook (1993) indicates that besides being cheaper, the "grapevine" finds employees who stay longer (low voluntary turnover) and who are less likely to be dismissed (low involuntary turnover) (Breaugh and Mann, 1984; Kirnan et al., 1989 cited by Heraty and Morley 1998: 666).

DeWitte (1989) reviewed five studies in which average labour turnover of those recruited by advertising was 51 per cent. The labour turnover for spontaneous applicants was 37 per cent and turnover for applicant recommended by existing employees was 30 per cent. Better informed candidates are likely to have a more realistic view of the job, culture of the organization and job prospects. Terpstra (1996) argues that recruitment sources are significantly linked to differences in employee performance, turnover, satisfaction and organizational commitment. In a survey of 201 large US companies, Terpstra asked respondents to rate the effectiveness of nine recruitment sources in yielding high-quality, high-performing employees. The three top ranked sources were employee referrals, college recruiting and executive search firms (cited by Heraty and Morley 1998, p. 666).

To sum up, what is evidenced here is that:

- There is a direct correlation in understanding the motivational factors of the current employee and the evaluation of recruitment and selection procedures.

- More people are getting employed through referrals.
- Employees recruited through referrals stay longer and are less likely to be fired.

So, what are the variables being considered?

If motivation is concerned with these factors which energize, direct and sustain human behaviour, then we need to look at three set of variables which constitute work situation. The conceptual model put forth by Porter and Miles (1974) proposes that these motivationally relevant factors must be viewed within a systems framework and we have to concern ourselves with inter-relationships and interactive effects among the various factors (Steers and Porters 1991).

Table 2.4

Individual Characteristics	**Job Characteristics**	**Work Environment Characteristics**
1. Interests	**1.** Types of intrinsic awards	**1.** Immediate work environment
		Peers
2. Attitudes	**2.**Degree of autonomy	Supervisors
Towards self		
Towards job	**3.**Amount of direct performance	**2.** Organizational actions
Towards aspect of the work situation		Reward practices
	4.Feedback	System wide rewards
3. Needs		Individual rewards
Security	**5.**Degree of variety in tasks	Organizational climate
Social		
Achievement		

Conceptual model put forth by Porter and Miles

(Porter and Miles 1984 cited by Steers and Porter 1991, p. 20)

The various theoretical approaches towards understanding motivation tell us that though theorists themselves have taken different approaches to the subject; the clear message is

that motivation is a complex process. It would be over simplistic to say that everybody will be motivated by money (winield et al. 2004, p. 118).

Most of this study's concerns/questions will also stem from the Hiltrap (1999) suggestions which he offers in his article "How Can Organisations Attract and Keep Talent?" (Hiltrop 1999, p. 424 426):

1. Start with the recognition that psychological contract is changing.

Most organizations will have to re-examine their career structures and look for other sources of 'security' to avoid excessive turnover and retain global talent (Mirvis and Hall 1994, cited by Hiltrap 1999, p. 424). In companies confronted with the risk of take-over, downsizing and even closure, a permanent redundancy policy - where employees can see at any time what they would be offered to leave may be necessary to reduce the cost of voluntary turnover.

2. Make the ability to attract and retain talent a top management priority.

The result of a study by Mckinsey (Chambers et al. 1998) show that only 23 per cent of some 6000 executives surveyed agreed that their companies attract highly talented people, and just 10 per cent said they retain almost all their high performers. More alarmingly, only 16 per cent think their company knows who the high performers are. And only 3 per cent said their company develops people effectively and moves low performers out quickly (Chambers et al. 1998 cited by

Hiltrop 1999, p. 424).

3. Create policies and practices that enhance the firm's attractiveness in the labour market.

Merely paying people more rarely is the most effective way to protect a company against poaching and many of the incentive programs companies have used to keep good people are so often riddled with inner contradictions that only end up creating more confusion and frustration.

4. Make line managers accountable for the people they need and lead.

According to the McKinsey team, companies should hold their line managers accountable for attracting. developing and keeping talent (Hiltrop 1999, p. 424).

5. Create a winning employee value proposition.

To test your organization's commitment to the quest for talent, ask the question: 'Why would a talented person want to work here?' Companies with a good talent pool have a compelling answer to this question. For some (e.g. BMW, Procter and Gamble, Microsoft), the advantage of having strong brands and products helps to get the best people interested in working for their companies (Hiltrop 1999, p. 425).

6. Provide opportunities for learning and self-development, Integrated with career planning and mentoring.

What matters now are job enrichment, employability and providing the opportunity for employees to develop the skills and perspective to take care of them (Noer 1993 cited by Hiltrop 1999, p. 425).

7. Provide information and support for the individual's own efforts at development.

Although organizations and managers cannot do much directly to develop a person's career, they can provide the necessary information and tools for self assessment and

development (Hall and Moss 1998 cited by Hiltrop 1999, p. 425). Some companies have tried to deal with this issue by making access to jobs more transparent. For instance, at Raychem, employees can tap into the internal-information interview network, to arrange interviews with other employees who are willing to talk about what jobs they do, and how they got to do them (Hiltrop 1999, p. 425).

8. Provide realistic job previews.

Research on the earliest stages of employment has shown that most people go into new jobs with inflated expectations and that unmet expectations during the initial stages of employment result in higher levels of employee dissatisfaction and turnover (Hiltrop 1999, p. 425).

9. Create challenging and career enhancing work experiences.

The challenge of work experience has been shown to be one of the most significant factors in the development of employee commitment and loyalty (Steers 1977; Meyers, 1989 cited by Hiltrop 1999, p. 425). Given this strong influence, efforts should be made to design tasks and structures that will enable talented employees to feel a sense of accomplishment, to express and use their talents, and to exercise their own decision-making powers (Hiltrop 1995, p. 425).

10. Redefine the role of human resource managers

To support the talent-building challenge, human resource managers need to be effective, proactive 'architects' with personal and business credibility and strong relationships with business units. The human resource business partner adds value to a firm through strategy execution, administrative efficiency, employee commitment, and cultural change (Hiltrop 1995, p 426)

The above ten points, vital as they are, help set the tone, as usual with Grounded theory research, to frame the research questions captured in chapter one.

CHAPTER THREE

METHODOLOGY

This study is a survey research centred on grounded theory research strategy. It employs interviews and questionnaire as methodological tools for data collection. The uniqueness of MTN is due to its overwhelming popularity as the leading telecommunication firm in Ghana, and Africa. The methodological framework for this study and analysis is based on qualitative and quantitative analysis with greater reliance on qualitative research.

3.1 A BRIEF ON MOBILE TELEPHONE NETWORK (MTN), GHANA

The MTN Group Limited (MTN Group) without doubt is the leading provider of communication services, offering cellular network access and business solutions. The MTN Group is listed in South Africa on the Johannesburg Stock Exchange (JSE) under the Industrial – Telecommunications sector.

Launched in 1994, the MTN Group is a multinational telecommunications group, with the vision "To be the leading provider of telecommunications in emerging markets". As at the end of December 2006, the group operating in 21 countries in Africa and the Middle East has recorded more than 40 million subscribers across its operations.

MTN Ghana (formerly an Investcom subsidiary trading as Areeba Mobile phone network under Scancom Ghana Limited) was granted a mobile cellular licence in December 2004, valid until December 2019.

The Ghana operation was incorporated into the MTN Group in July 2006. Since then, the company introduced discounted off-peak calls; bulk SMS, GPRS and EDGE

services and a wireless mobile office package that is particularly effective in rural areas where there is limited data connectivity. The company also introduced GPRS roaming in Ghana, South Africa and Nigeria. These initiatives have enhanced subscriber numbers and retention. MTN's Ghana operation significantly increased its geographic coverage during the year, adding over 400 base transceiver stations, three base station controllers and three mobile switching centres. Substantial progress was made in completing microwave backbone transmission rings, enabling MTN Ghana to reduce future transmission costs and penetrate new areas.

Market penetration of telecommunications services, particularly mobile phone usage, is growing exponentially. The customer service department is assumed to be better shaped following the success chalked among the Ghana club 100. With the scale of MTN Group resources to draw on, MTN's operations in Ghana are well positioned to capitalise on this trend. (MTN Annual Report 2006 published on 18 May 2007).

3.2 RESEARCH STRATEGY

This study being exploratory in nature was conducted with a grounded theory research strategy which emanates from the reviewed literature. Grounded theory is fashioned on qualitative research. Qualitative research is preferred because of its numerous advantages. According to Wimmer and Dominick (2003)"qualitative technique can increase a researcher's depth of understanding of the phenomenon under investigation. However, the researcher made use of some figures and statistical instruments that fall within the ambit of quantitative research.

When it comes to the methods of measurement, a researcher can use methods which can seem very objective and 'fair'. On the other hand, if we want to know what individuals

think, we would have to ask them. The more people we interview, the more opinions we receive which cannot be easily compared.

3.3 SAMPLING

This study concentrated on the employees in the customer support and service department of MTN as the population for this study.

Purposive or Judgemental sampling was employed to select the sample customer service points and the respondents for this study. Twenty customer service points were selected within the Greater Accra, Volta Central and the Eastern regions of Ghana. The researcher first was assisted to select five customer service points in each region based on the number of five or more employees being present within a day at the customer service centre. The researcher was given a full list of employees at these service points. Since the adopted sampling approach is purposive, the researcher eliminated those who worked less than three years. A questionnaire was then administered to all the 236 employees that satisfied the researcher's criteria. Thus, intended to be a census study but then it is termed 'census' only if data is collected and analysed from every possible case or group member (Saunders et al. 2007: 204). However, questionnaires analysed were reduced to 42.

Purposive sampling according to Wimmer and Dominick (2003:88) is the most essential for this study because, as they argue, "a purposive sample includes subjects or elements seleccted for specific characteristics or qualities and eliminates those who fail to meet these criteria". Therefore, by adopting this sampling technique, it accommodates the range of research questions, which are central to this study.

3.4 DATA COLLECTION

The researcher administered a set of questionnaire to all who worked with MTN from three years above at the selected service points in the four regions mentioned above. The researcher also interview individuals believed to be knowledgeable or has the ability to contribute meaningfully to this study. For the interview, the researcher allowed for self-selection sampling where the respondents identified were given the freedom to decide to take part in the research (Saunders et al. 2007: 335). However, due to the shift system being run at the most customer service points by MTN, the researcher was assisted to select the interviewees.

Designing the Questionnaire and Interview Questions

The open-ended questions were designed to encourage the participants to provide an extensive and developmental answer and may be use to reveal attitudes or obtain facts (Grummitt 1980 cited by Saunders 1997: 226). Some of the questions in the questionnaire were framed using projective techniques in which the approach is association: the 'say-the –first-thing-that-comes-to-your-mind' approach which is based on the assumption that a fast response to a stimulus word, picture or question will be less 'guarded' and therefore more revealing of underlying attitude and motives (Oppenheim 1992: 139).

The other issue has to do with comparisons when we use more than one technique to measure the same attribute or variable. Suppose that we asked a number of questions to measure attitude to abortion, and that, on our first question, we have found that 62% of the middle-class respondents to be 'in favour'. It only acquires meaning when compared, say, to a response of 48% 'in favour among working-class respondents. Taking a look at differently worded questions on abortion, it's found that 53% of the

middle-class respondents gave a favourable reply. Nevertheless, the relative differences may well be quite stable and consistent in their direction, no matter how the question is phrases. In social research, there are few absolute measures, but relative measures are well worth having if they are consistent. They constitute a 'real' finding and can give an indication of relationships between underlying variables (Oppenheim 2003: 288-289).

On the use of Likert's scale, Cohen et al. (2000) contend that it is illegitimate to the intensity of feeling between strongly disagree and disagree is equivalent to the intensity of feeling between other consecutive categories on the Likert scale. The response categories in likert scales have a rank order, but the intervals between values cannot be presumed equal (cited by Jamieson 2004: 1217).

The interviews were semi-structured interview. In this, the researcher had a list of themes and questions to be covered, although these varied from interview to interview given the specific contexts which were encountered (Saunders et al., 2007) the researcher tried to answer the questions before settling on them.

Table 3.2 below shows the working towards building the questionnaire and interview questions. (See Appendix for the questionnaire distributed).

Table 3.1

Which variables are being looked at?	Details in which data is measured	Question number in the survey	Questions asked in the interview
	What do them actually prioritized?	14, 15	Explored in more Detail
Types of intrinsic rewards			Covered here
Immediate Work environment			Covered here
Degree of autonomy	Are their jobs monotonous?	12	Explored here
Attitudes towards self, job and aspects of work situation	What do they actually feel they need from their jobs?	7,8,9,12,13, 16, 17, 18, 19.	Explored in more Detail
Do employee attitude differ based on Age? Gender? Employee status? Working mothers? Location?	Age Gender Full / Part time Married / not married With/without children Postcode	1 to 6	

Questionnaire Data Requirements Table

(Adapted from Saunders et al. 2007: 365)

3.5 DATA PROCESSING AND ANALYSIS

Two sources were considered for data. These were primary data from self – administered questionnaires and unstructured interview. The secondary data used in this study was a past conducted survey report. The data collected was processed into graphical representations using the Microsoft Excel office programme. The interview recorded was later transcribed into a tabular form by an expert for analysis.

The two sources of data were considered so that there could be a buffer in case there was a problem with accessing any of the sources. As mentioned earlier, triangulation was proposed as a way to implement them. Refining the concepts of corroboration and validation, triangulation consists of strengthening qualitative findings by showing that several independent sources converge on them, or at least, do not oppose them (Decrop 1999: 157).

Memos were used as one of the aids for the generation of the concepts and categories. This served as a reminder about what is meant by the terms being used and provided the building blocks of the theory (Bryman 2004: 405). One of the statistical analyses which were thought of was the use of contingency tables. The chi-square test of whether two or more populations have the same probability distribution, but it is also a test of the independence of two categorical variables (Swift and Piff 2005: 689). However, a lot of statistical analyses demand that the number of questionnaires be substantial for the results to mean something.

3.6 RELIABILITY AND VALIDITY

Qualitative approaches are criticized because of their lack of rigor and credibility. Both are put into question since homogeneity of data and coefficients of determination cannot be computed. This issue of soundness goes beyond the quantitative/qualitative debate (Maxwell & Rossman 1995: 143, cited by Decrop 1999: 158). To achieve reliability and validity, the researcher relied on the four criteria developed by Lincoln and Guba (1985) for qualitative inquiry that parallel the quantitative terminology. These are as follows;

1. Credibility (internal validity): how truthful are particular findings?
2. Transferability (external validity): how applicable are the findings to another setting or group?
3. Dependability (reliability): are the results consistent and reproducible?
4. Confirm-ability (objectivity): how neutral are the findings (in terms of whether they reflective of the informants and the inquiry, and not a product of the researchers biases and prejudices)? (Cited by Decrop 1999: 158)

Reliability is about purity and consistency of the measure and validity is whether the question, item or score measure what it is supposed to measure (Oppenheim 1992: 144-145).

Triangulation is one of the means of tackling this. It means looking at the same phenomenon, or research question, from more than one source of data. Information coming from different angles can be used to corroborate, elaborate or illuminate the research problem (Decrop 1999: 158). The use of other data sources (interviews and secondary data) allows "the research to increase the validity of their research through triangulation" (Bryman and Bell 2004: 144). By combining data sources, methods,

investigators, and theories, triangulation opens the way for richer and potentially more valid interpretations (Decrop 1999: 159). This research tends to be more towards method triangulation which entails the use of multiple methods to study a single problem.

3.7 ETHICAL CONSIDERATIONS

There are various ethical principles involved in social and business research. The principle of voluntary participation requires that people should not be coerced into taking part in the research. Also, closely related to the notion of voluntary participation is the requirement of informed consent. Essentially, this means that prospective research participants must be fully informed about the procedures and risks involved in the research before allowing them to give their consent to participate. Ethical standards require that participants are not put in a situation where they might be at risk of harm, both physical and psychological, as a result of their participation (Trochim, 2006).

To make sure that ethical issues were taken into consideration, a covering letter was attached with the questionnaire which explained the purpose of the questionnaire and informed the participants that no information identifying the respondents will be disclosed under any circumstances and only the researcher will have access to them. (Refer to Appendix A). In the case of the interviews, before the start of the interview, the participants were asked for their consent and informed that they were free not to answer any questions they were not comfortable with. Also, they assured that identifying information will not be made available to anyone who is not directly involved in the study.

Another issue considered was about the ownership of data and conclusions – after collection and analysis who owns the data and the conclusions. How will the research results be reported and disseminated? (Miles and Huberman1994 cited by Punch, 2000:59). For this, a confidential agreement was reached between the researcher and MTN which prohibits the divulging of any information or publishing this research. This contract will be honoured by not disclosing any information without the expressed consent from the researcher and MTN.

3.8 LIMITATIONS

This refers to the restrictive weaknesses (Locke et al. 1993: 18 cited by Punch 2000: 75) which are unavoidable in the study's design. This is useful in avoiding any misunderstandings by the reader.

The participants for the interview:

The persons for one to one interview were chosen by MTN. We need to keep in mind that all of the three participants who were interviewed have been working in the company for a considerable length of time.

- Interviewee one (1) has been working in MTN, for 3 years (worked for 5 years in the previous company)
- Interviewee two (2) has been working in MTN, for 7 years (worked for 10 years in the previous company)
- Interviewee three (3) has been working in MTN, for 4 years (worked for 3 years in the previous company)

This could be seen as a limitation because all of these participants seem internally motivated and are not the types who would 'complain'. In most employment situation where intrinsic motivation is meant to be high, the employee usually desires continued employment: he/she forms personal associations with co-workers and he /she develops capital specific to his/her job and employer (Kreps 1997, p. 360). The responses from these interviewees could be presumed to be distorted by the fact that they were protective and sceptical of management.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.0 INTRODUCTION

The data gathered from the two principal sources described in the previous chapter is presented and analysed based on the research questions. This chapter present the results produced by this study and findings from these results are summarised in the next chapter. The results of this study pertaining to the questionnaire and structured interview are presented first follow by the secondary data.

The secondary data used in this study was a previously conducted internal survey report. The researcher got late access to the report which was after the questionnaire was administered and the interviews were over.

The researcher based on the adoption of the purposive sampling technique explained in the methodology (3.3 Sampling), selected 236 customer service employees from the customer service points in the Greater Accra, Volta, Central and the Eastern regions of Ghana who were surveyed. The total number of adequately filled questionnaires was 42 after going through data reduction due to the adequacy of the filled questionnaires. Thirteen women (inclusive of 4 part timers) and 29 men responded to the questionnaire. There was only four part timers' who responded - all of them women. That means that the overall response rate is a low 17.8%.

In the internal report, the response to the survey has been as high as 98.92 per cent for some of the questions. This very high response rate gives the secondary survey report a

very high validity. This section begins with the findings from the questionnaire and the interviews conduct by the researcher. These findings has been used to determine how this relates to the secondary data from the survey which has got very good validity.

4.1 FINDINGS FROM PRIMARY DATA

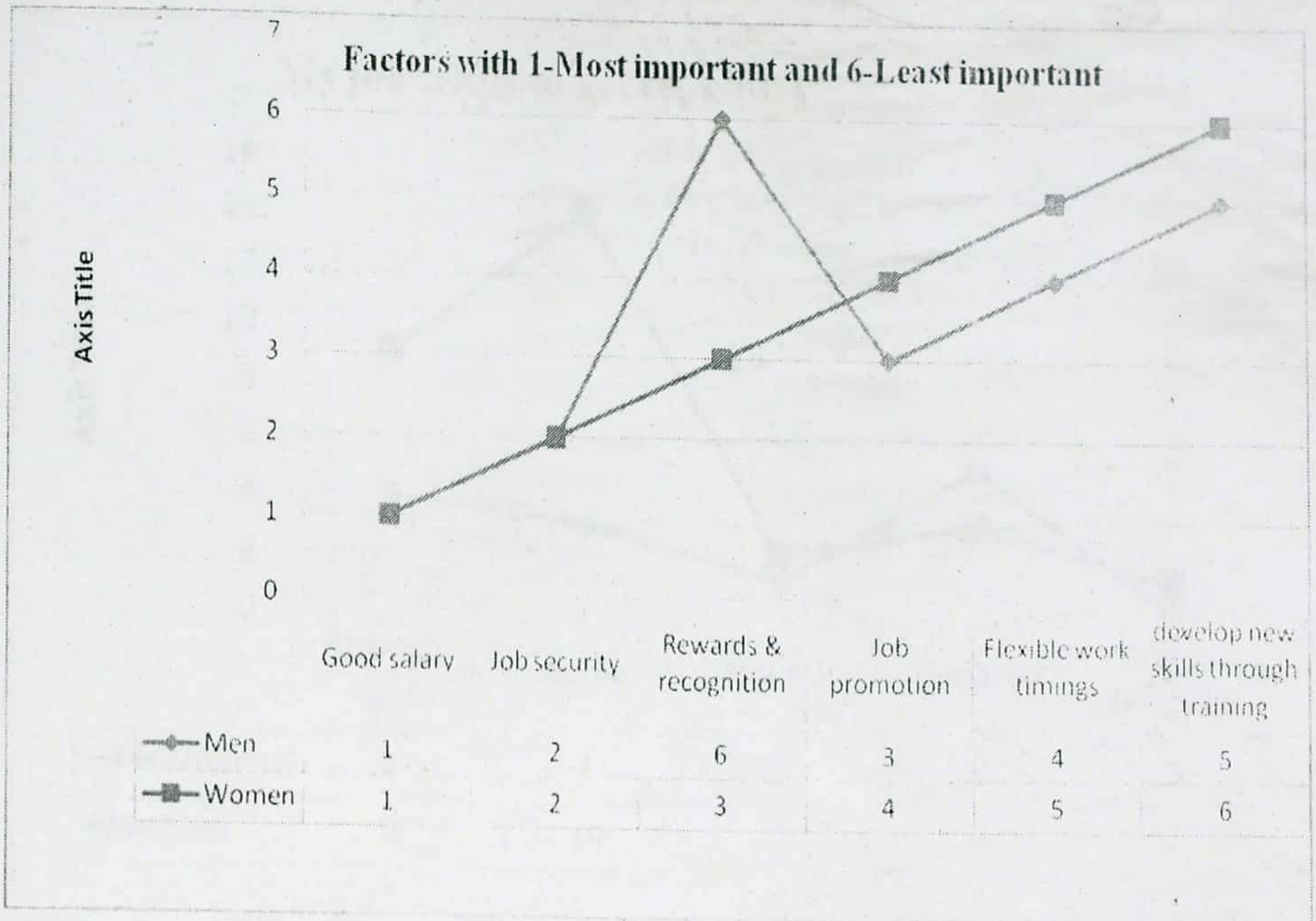
Do men and women have different motivational factors?

In a bid to find out the differences in motivational factors of men and women, the employees were asked to rank a list of 6 factors they considered important with 1 being the most important to 6, the least important.

As seen from figure 1 below, apart from the fact that good salary and job security ranked the number 1 and 2 factors, flexible work timings seem to be a concern for the women. When asked whether they would prefer flexible working hours, out of the13 women who responded, seven (7) of them strongly agreed and the rest agreed. None of the women disagreed.

In their response, under Good salary, the ranking for both women and men is 1; also, job security is 2 for both sexes. Flexible work timings saw the women with 3 and the men 6. For Job promotion, it is 5 for the women and 4 for the men. On the factor of to 'develop new skills through training', it is 6 and 5 respectively. This is transcribed unto the figure 4.1.1 below

Figure 4.1.1

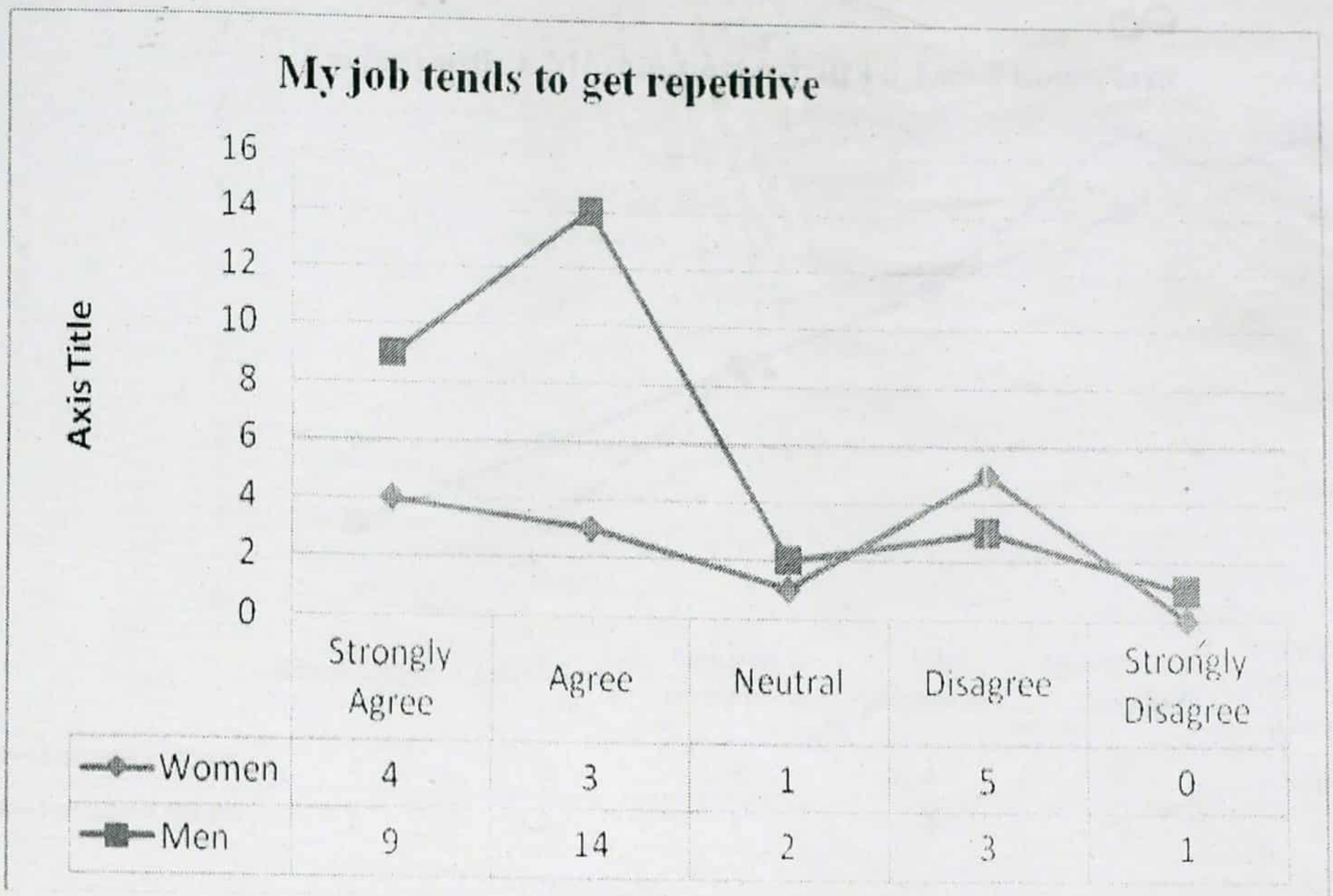


Ranking of the six important options in the job by women/men

(Source: Questionnaire)

Figure 4.1.2 below indicate the response to the statement that they found their job repetitive, 23men agreed (inclusive of 9 who strongly agreed) while 4 men disagreed. As you see, there was no consensus among women. This graph shows that men tend to find their job to be more repetitive. It was interesting to note that among women, all the 4 part timers found the job not to be repetitive.

Figure 4.1.2



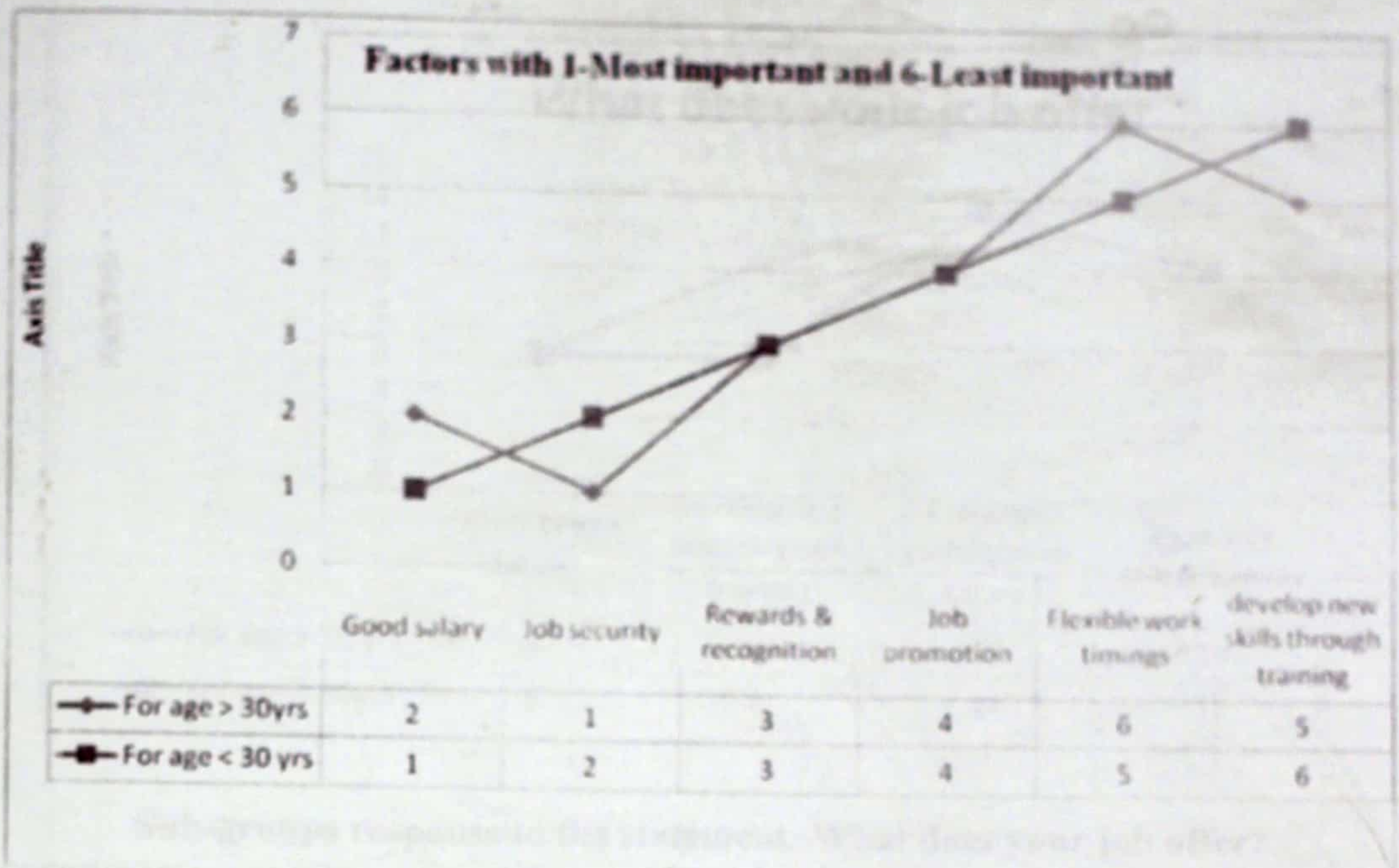
Sub-groups response to the statement: My job tends to get repetitive

(Source: Questionnaire)

So, did the preferences changed as we moved across the ages?

There were 20 employees aged less than 30 years and 22 employees aged more than 30 years who responded back to the questionnaire. Figure 4.1.3 indicates the rankings of the six factors as we try to differentiate between the 2 groups. Job salary and job security still take the top 2 spots. As can be seen, there is no clear difference between the respondents aged below 30 and over 30 years. It was not possible to differentiate across age like 20-30, 30-40.....because of low number of respondents to the questionnare.

Figure 4.1.3

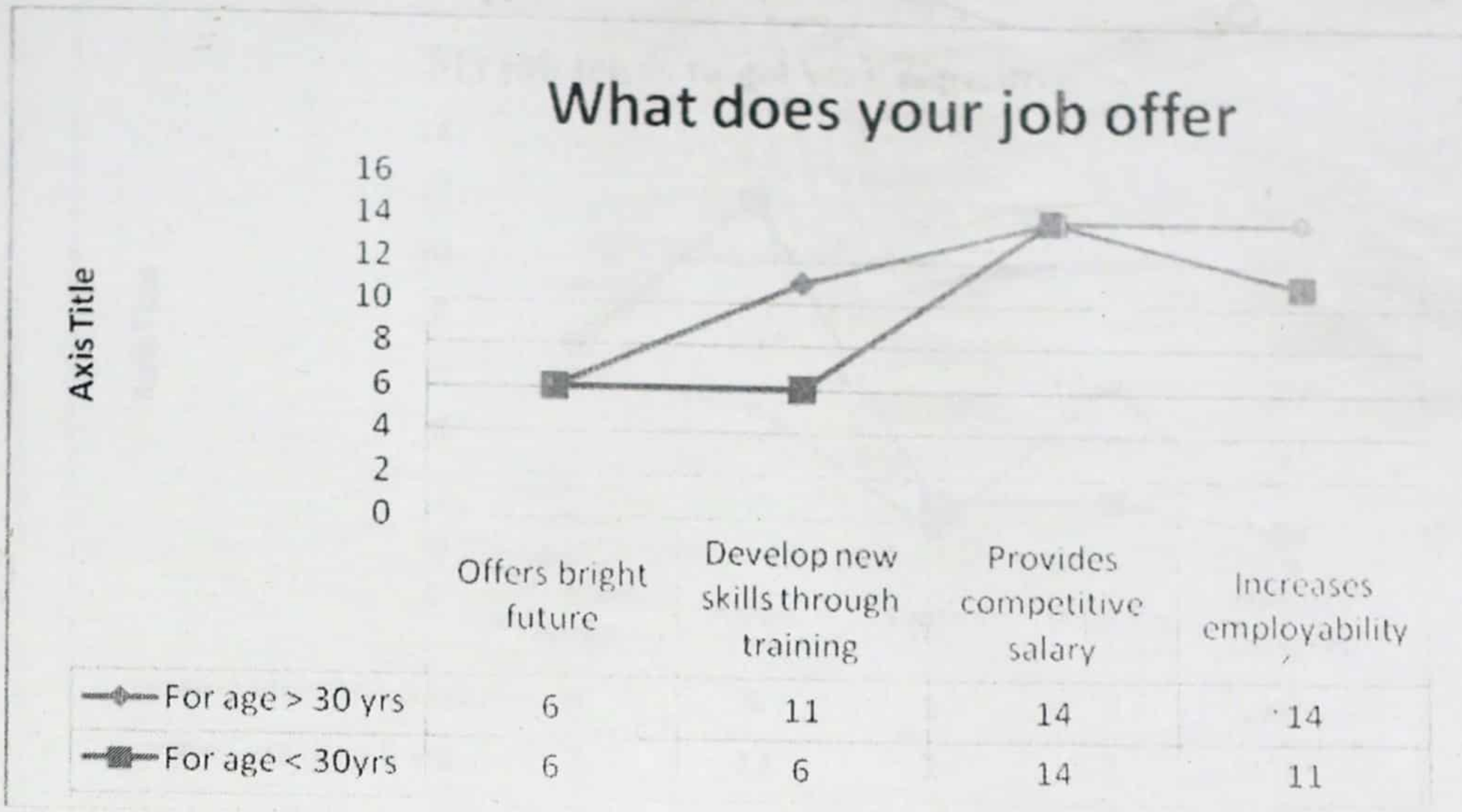


Sub-groups ranking of the six options from most important to least important

(Source: Questionnaire)

When asked what did their job in MTN offer them, competitive salary came in first with the prospect of their employability increasing (the chances of finding a good job in other companies) coming in second as shown in figure 4.1.4. It's important to note that the option'offers bright future' came in last.

Figure 4.1.4



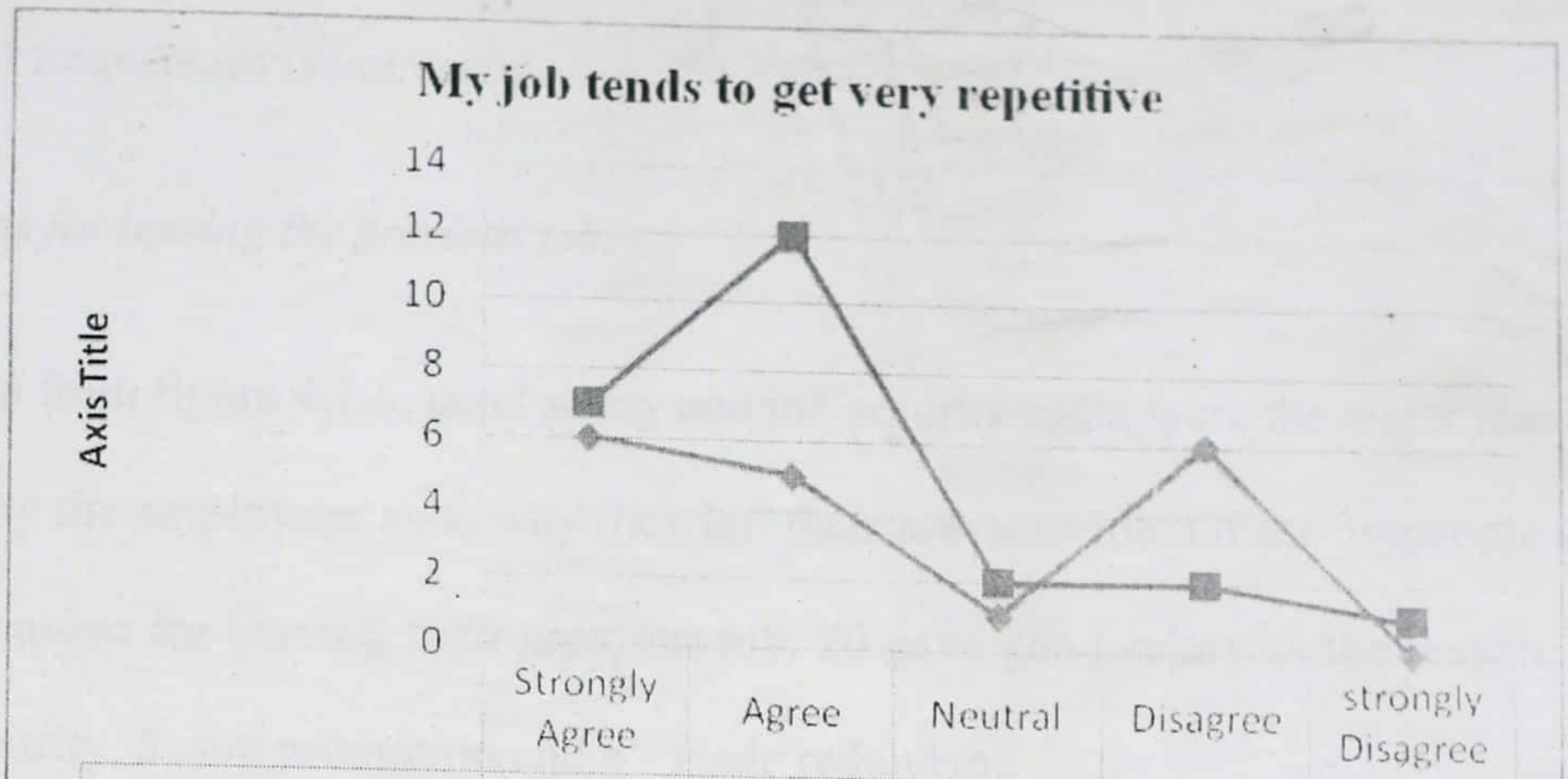
For age > 30 yrs	6	11	14	14
For age < 30yrs	6	6	14	11

Sub-groups response to the statement: What does your job offer?

(Source: Questionnaire)

It would be interesting to see whether the people who have stayed in this job for long time would find this job repetitive. Out of the 42, 19 employees who have been working for less than 5 years agreed (inclusive of 7 who strongly agreed) and 3 disagreed (inclusive of 1 who strongly disagreed). As seen from figure 4.1.5, there was no strong consensus among employees who have been working for more than 5 years.

Figure 4.1.5



	Strongly Agree	Agree	Neutral	Disagree	strongly Disagree
More than 5 yrs	6	5	1	6	0
Less than 5 yrs	7	12	2	2	1

Sub-groups response to the statement: My job tends to get repetitive

(Source: Questionnaire)

As pointed out at the beginning of this section, the number of respondents being small, these data do not let statistical analysis being performed on them. Suppose we performed a chi-square test on the table shown in figure 4.1.5 above, we get the results as:

Chi-square = 5.549

D.F. = 4

WARNING: 2 cells expected counts less than 1. The chi-square approximation is probably invalid. Six (6) cells expected counts less than 5.

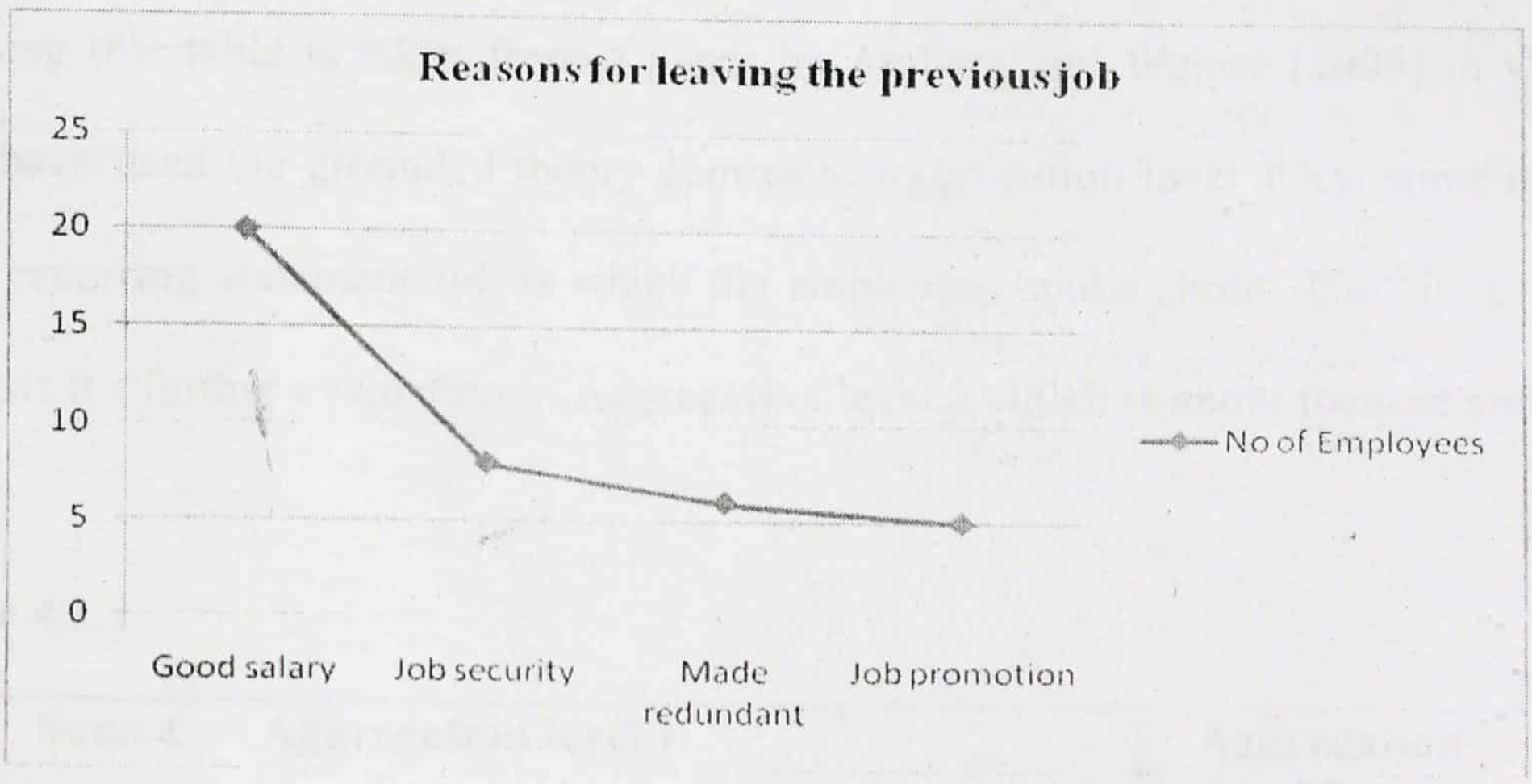
The chi-square test of significance is useful as a tool to determine whether or not it is worth the researcher's effort to interpret a contingency table. A significant result of this test means that the cells of a contingency table should be interpreted. A non-significant test means that no effects were discovered and chance could explain the

observed differences in the cells (Stockburger, 1998). In this case, an interpretation of the cell frequencies is not useful.

Reasons for leaving the previous job:

As seen from figure 4.1.6, good salary and job security again were the major reasons given by the employees as to why they left their previous job. Of the 39 people who gave reasons for leaving their previous job, 20 gave good salary as the reason, 8 - job security, 5 -job promotion and 6 - made redundant.

Figure 4.1.6



Reasons given by the emploees for leaving their previous job
(Source: Questionnaire)

About the part-time employees:

The response to the question whether the employees feel that the part-timers have fewer chances of promotion in the company was mixed. Two of the four part-timers who responded were neutral about this statement. The full time employees were divided about this statement. Again, with a low response of 42 respondents, there was nothing conclusive that could be said

by the questionnaire. When you look at the answers given by the part time employees to the other open-ended questions, the researcher felt that part-timers weren't really concerned whether promotion was on the cards. As quoted by the part-timers during the interview:"Maybe, being a part-timer affects your job promotion a little bit.....Not really." (Source: IN-1). Table 4a summarizes the other findings from the interviews and the open ended questions of the questionnaire.

Findings from the interviews and open ended questions

This table is an attempt aimed at the implementation of the coding process. The idea of using this table is taken from a paper by Amberg and Weiner (2005) in which they have used the grounded theory approach. Aggregation level 1 has some of the most recurring statements/ideas which the employees spoke about. This list is used as basis for further evaluation in Aggregation level 2 which is about focused coding.

Table 4.1.1

Source	**Aggregation level 1**	**Aggregation level 2**
SU-15	I want to be able to go and teach before I come to work	Flexible working hours is a top priority for women-good salary and bonus comes in after that.
IN-2	This salary is like a pocket money	
SU-30 SU-37 SU-35	More flexible in working hours and attitude towards childcare	
IN-1 IN-2	You need to be very self motivated to do this job...it require lot of hard work	
IN-2	I am not looking for any promotion or lateral growth.	
SU-15 SU-23 SU-28	It know of people coming from Tema even though there are lot of other call centers there because of bonus	
IN-1	It would be nice to know what the other departments are doing	Part-timers

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SU-30 IN-1	We want flexible working hours....Its nice to be able to miss the traffic.	seemed internally motivated and they do feelthe lack of communication
IN-1	I do the same personal/team objectives as a full timer does but I have few hours to achieve that.	
SU-26 SU-28 SU-30	Great working environment. Love talking to customers.	
SU-22 SU-4	I am looking for a more varied, possible field- based role	Men have growth (in terms of promotion) on their mind and looking for variety in their job
IN-3 SU-1	Clear progression plan...I'd also like to see profit sharing	
SU-24 SU-31 IN-3	After nearly four years in my current role, I feel a need for a change	
SU-13	More opportunities to progress through the ranks	
SU-6	I would want the company to give me all the information I need to do my job properly.	
SU-10	Less administration, a more structured career progression path	
SU-42	To make other related areas of the company that connect to mine feel more of a joint team	Lack of communication about the objectives of what the company is trying to achieve.
SU-40	Communicatiion between upper levels of management and the shop floor needs to be improved.	
IN-3	Would like to know exactly what needs to be done to be able to earn more incentives.	
SU-41	Make it possible to experience other areas of the business on a more frequent timescale.	
SU-8	More stability! Stop changing for changing sake	
SU-5 IN-3	That they would listen to the staff and reverse some bad decisions	
SU-11	The company is unable to learn from mistakes.	

Implementation of the coding process
(Adapted from Amberg and Weiner, 2005)

What do we understand from the primary data?

- Good salary and job security have been the top two motivating factors which did not change with age, sex and whether they are part-time employees. These two are the main features which have attracted these employees to work within MTN.

- Women and part timers want flexible working hours. Though every employee would prefer more money, they want to be able to have a healthy work/ home life balance.

- Men want to have a clearer idea about the career progression in terms of their job promotion.

- There is a lack of communication between the upper management and the floor. Employees do not feel they have formed a bond with MTN. This can be seen in the two responses below:

'We had alerted the management about this one particular service product with some defects in it before they launched it in the market. They still went ahead with it and surely, there were problems." (Source: Interviewee 3)

"Our team was moved from small business division in the metropolis to the Accra business centre-market division. And again, we were moved back to small business division. They don't know where to put us."(Source: Interviewee 1)

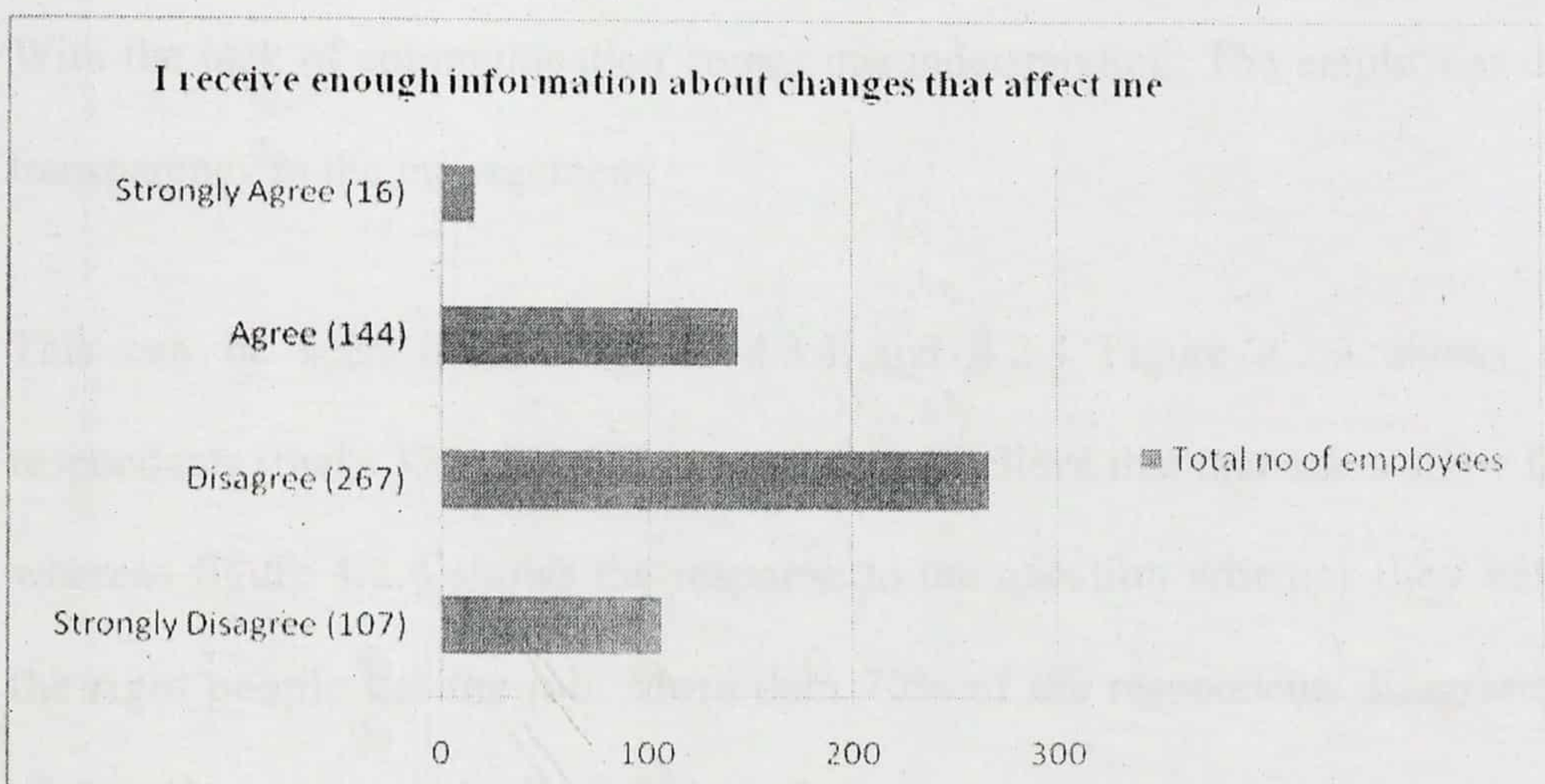
4.2 FINDINGS FROM THE SECONDARY DATA

This secondary data is from the company's own survey internal report. The response to the survey has been as high as 98.92% for some questions. Please note that there were approximately 540 employees at the time in that department in MTN, as per the information provided by MTN. A very high response rate gives this survey very high validity.

What the employees have to say about communication?

As pointed out by the primary data, lack of communication is felt by the respondents. Let's look at figures. Of the 534 employees who responded to the question whether they received enough information about changes that affect them, 374 employees disagreed (inclusive of 107 who strongly disagreed). This is 75% of the total respondents.

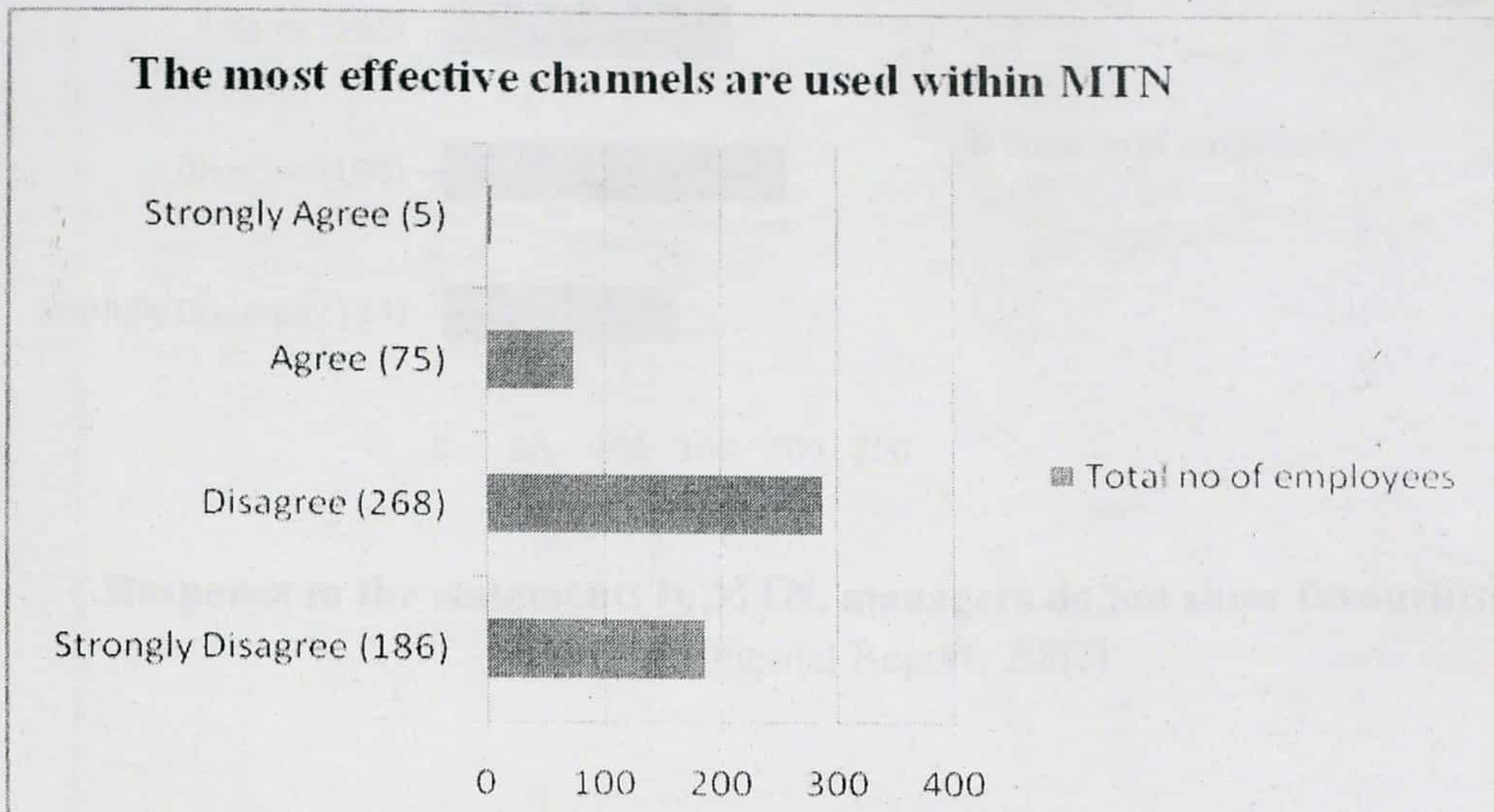
Figure 4.2.1 Response rate: 98.92%



Response to the statement: I receive enough information about changes that affect me
(Source: Internal Report, 2007)

Figure 4.2.2 shows that 85% of the respondents believe that the effective channels are not being used. 454 out of the 534 respondents disagreed that the most effective channels are being used

Figure 4.2.2 Response rate: 98.92%



Response to the statement: The most effective channels are used within MTN

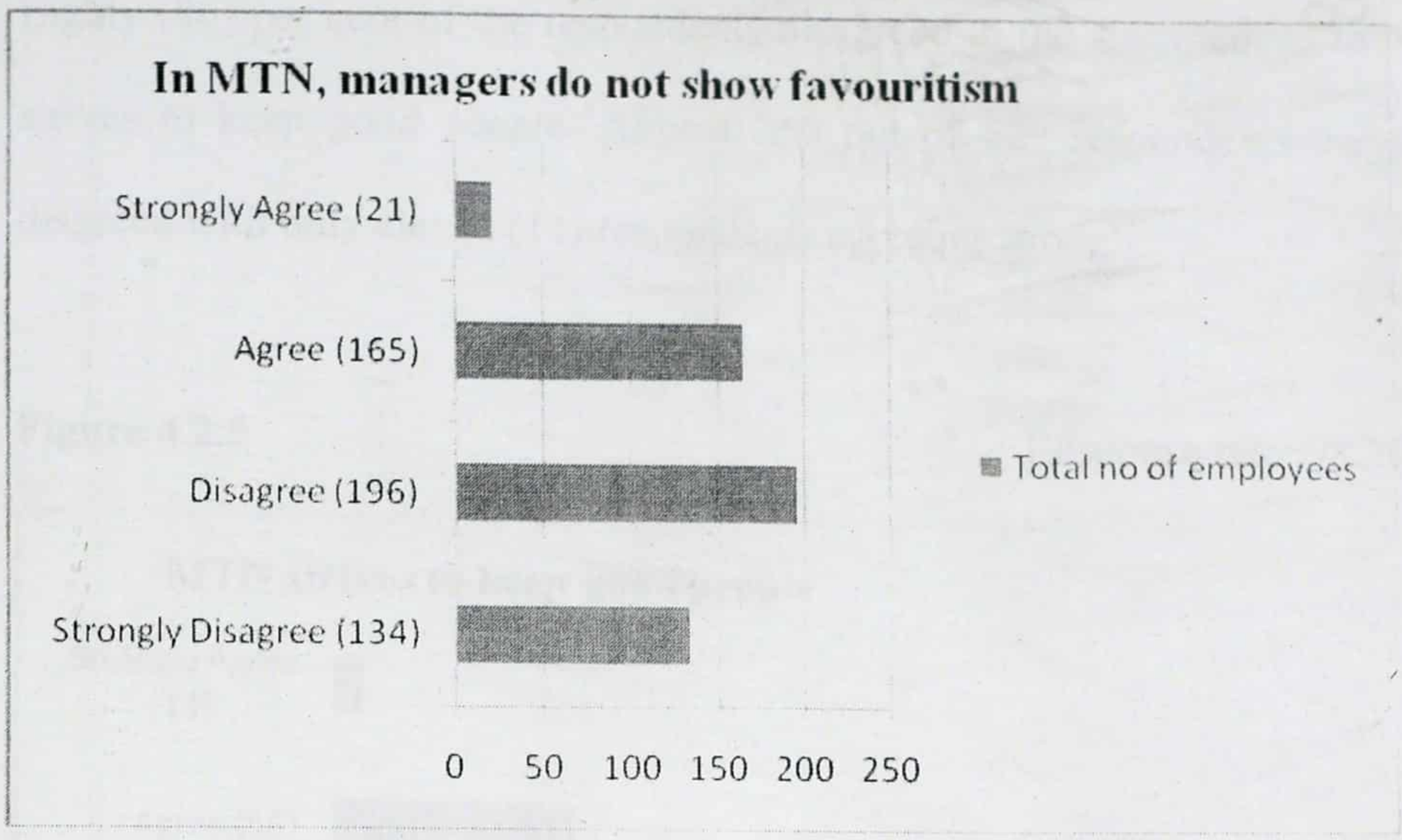
(Source: Internal Report, 2007)

With the lack of communication comes misunderstanding. The employees do not see transparency in the management.

This can be seen in the figures 4.2.3 and 4.2.4 Figure 4.2.3 shows that 64% respondents (that's 330 out of 516 respondents) believe that managers show favoritism whereas figure 4.2.4 shows the response to the question whether they believe that the right people get the job. More than 70% of the respondents disagreed inclusive of the 44% who strongly disagreed.

Figure 4.2.3

Response rate: 95.68%

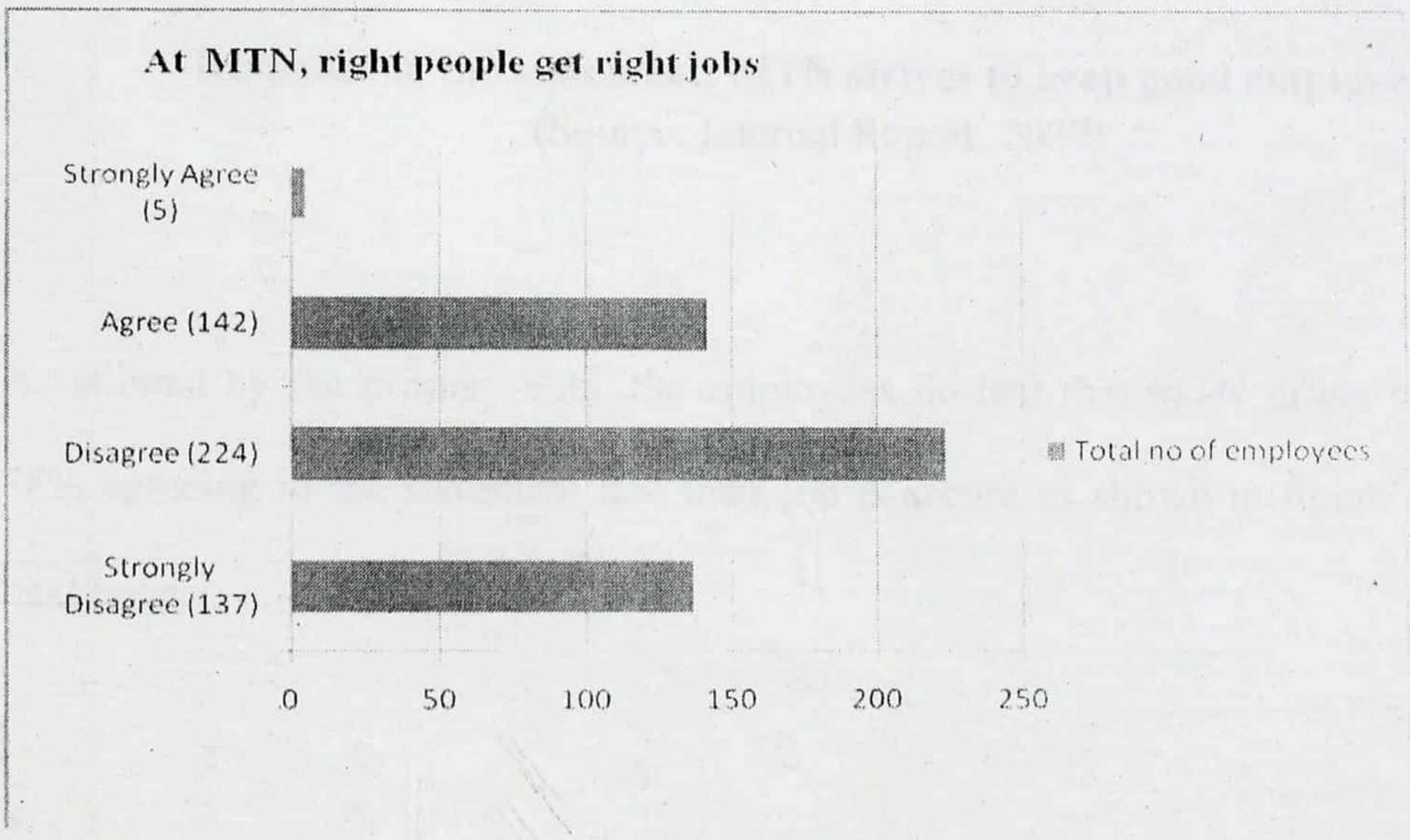


Response to the statement: In MTN, managers do not show favouritism

(Source: Internal Report, 2007)

Figure 4.2.4

Response rate 94.24%



Response to the statement: At MTN, right people get the right jobs

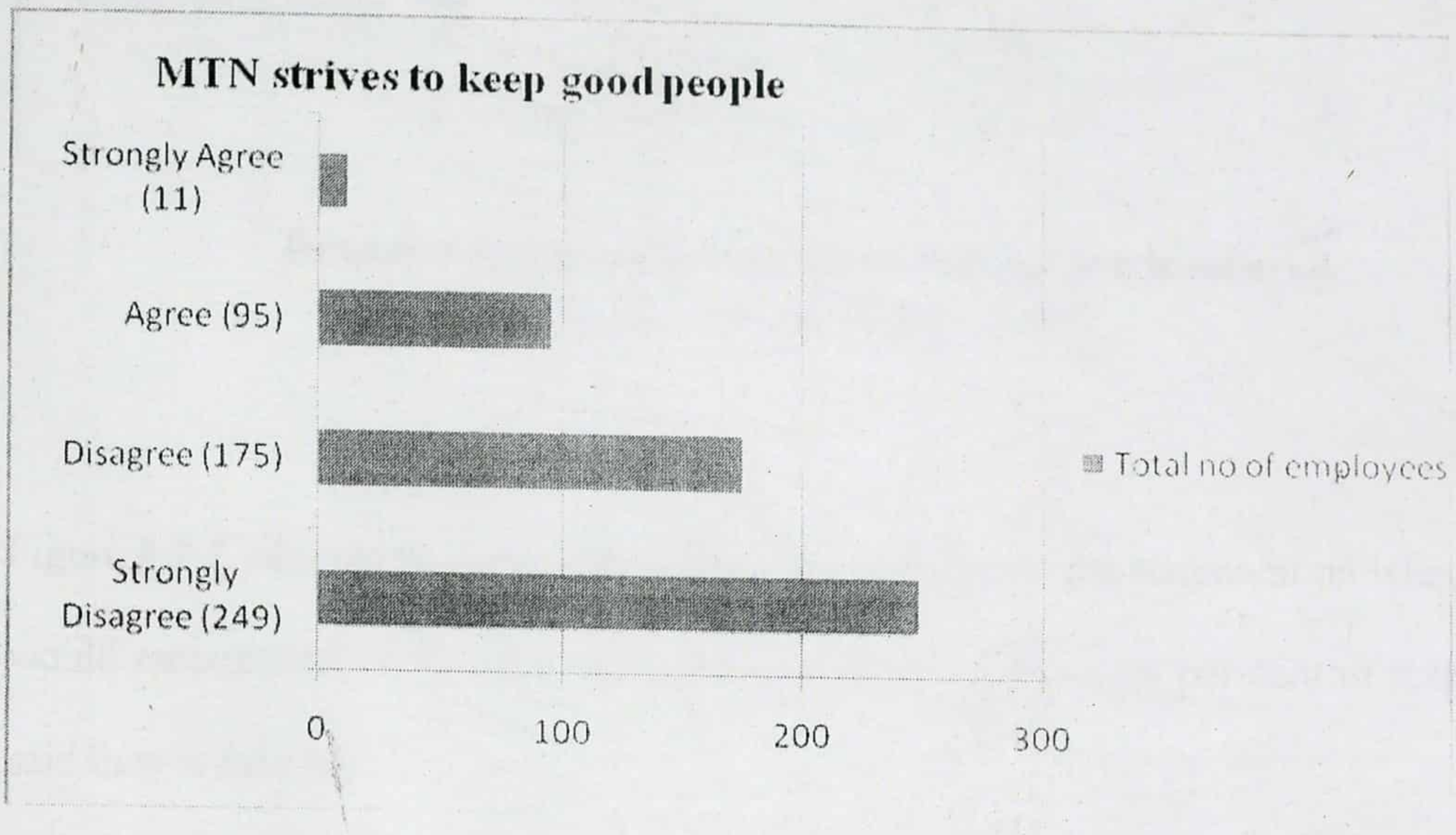
(Source: Internal Report, 2007)

Do employees feel whether MTN cares?

Eighty (80) per cent of the respondents disagreed to the statement as to whether MTN strives to keep good people. Almost 250 out of 529 respondents surveyed strongly disgreed with only eleven (11) respondents agreeing strongly.

Figure 4.2.5

Response rate: 98.20%

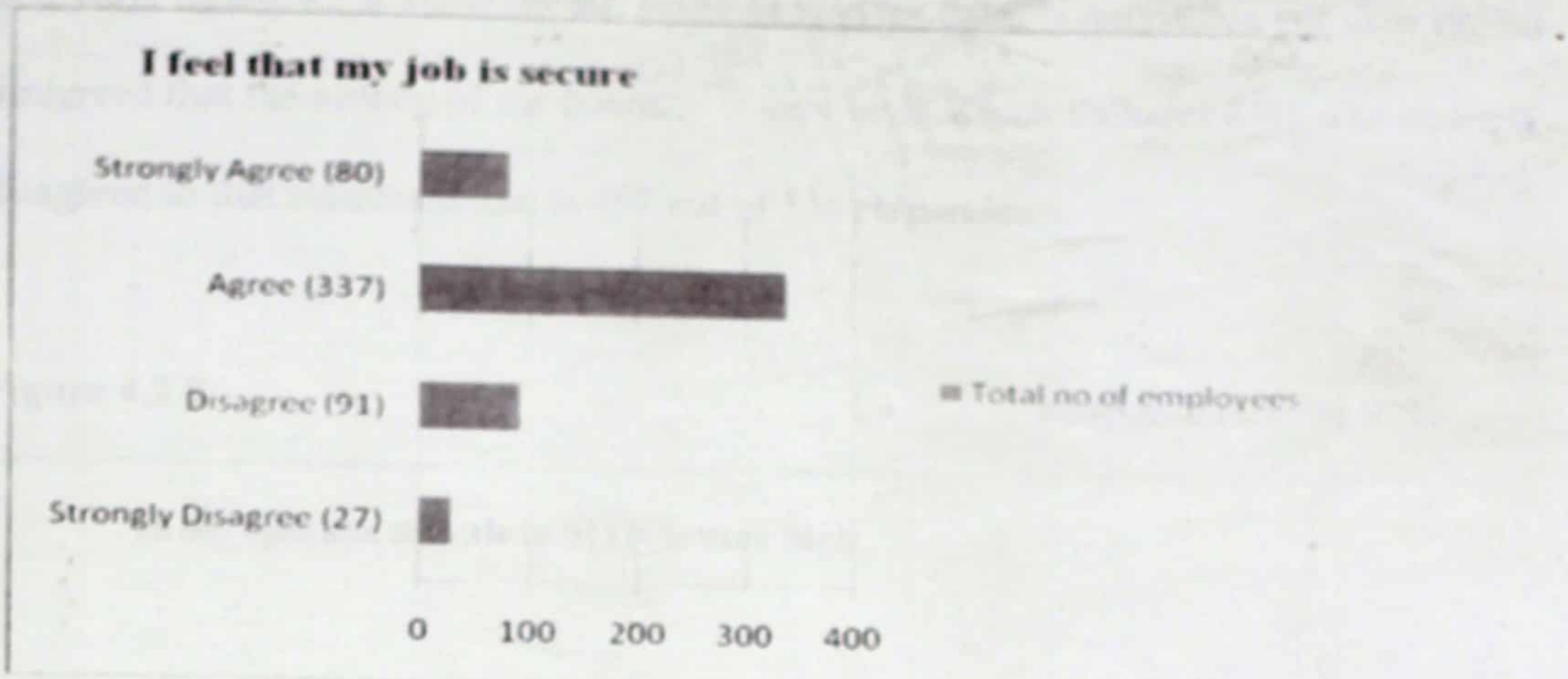


Response to the statement: MTN strives to keep good employees
(Source: Internal Report, 2007)

As pointed by the primary data, the employees do feel that MTN offers security with 78% agreeing to the statement that their job is secure as shown in figure 4.2.6 on the next page.

Figure 4.2.6

Response rate: 98.02%

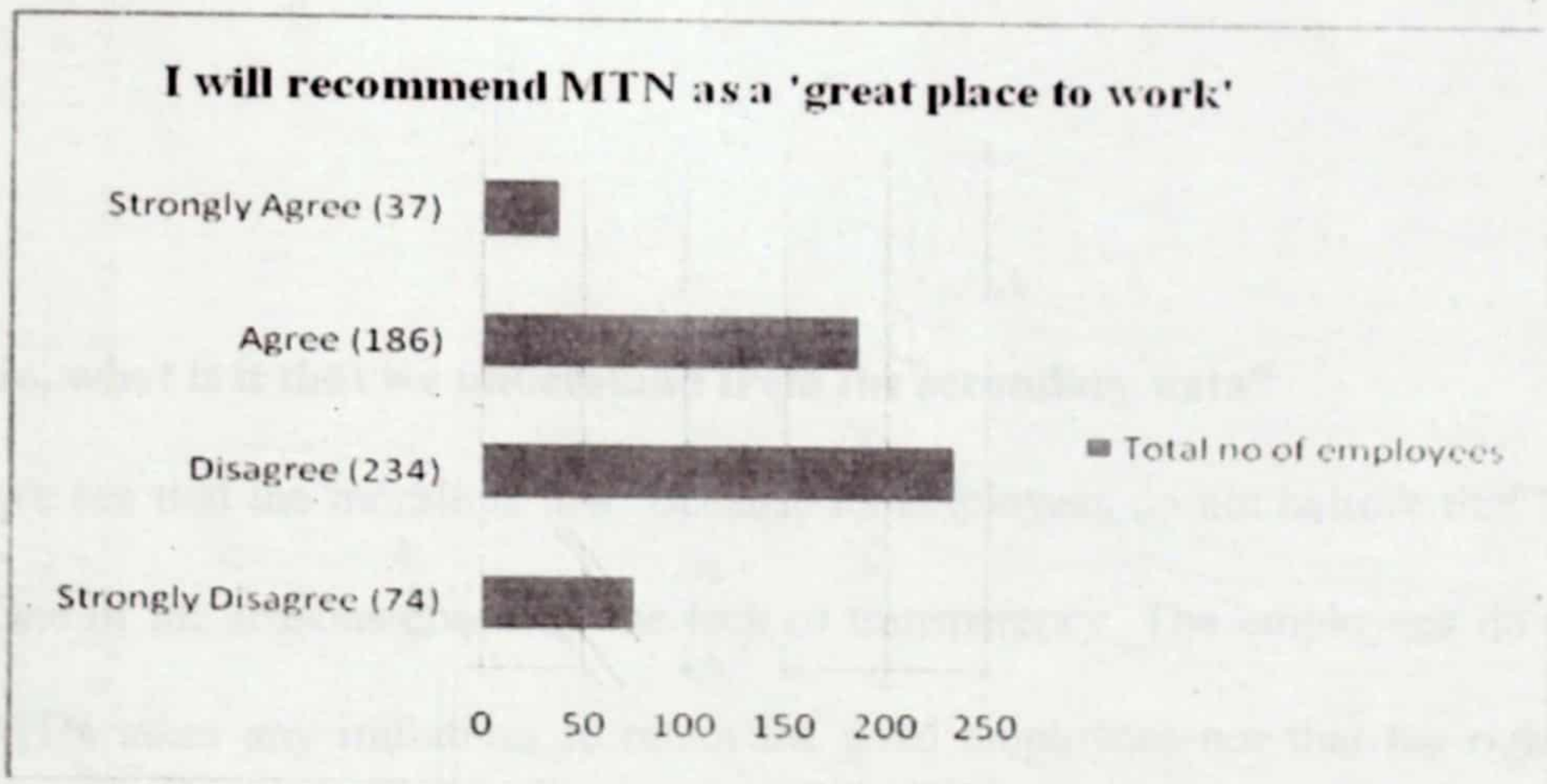


Response to the statement: I feel that my job is secured
(Source: Internal Report, 2007)

Figure 4.2.7, also on the next page, shows the response to the statement on whether they would recommend MTN as a 'great place to work'. Fifty-eight per cent of respondents said they would not.

Figure 4.2.7

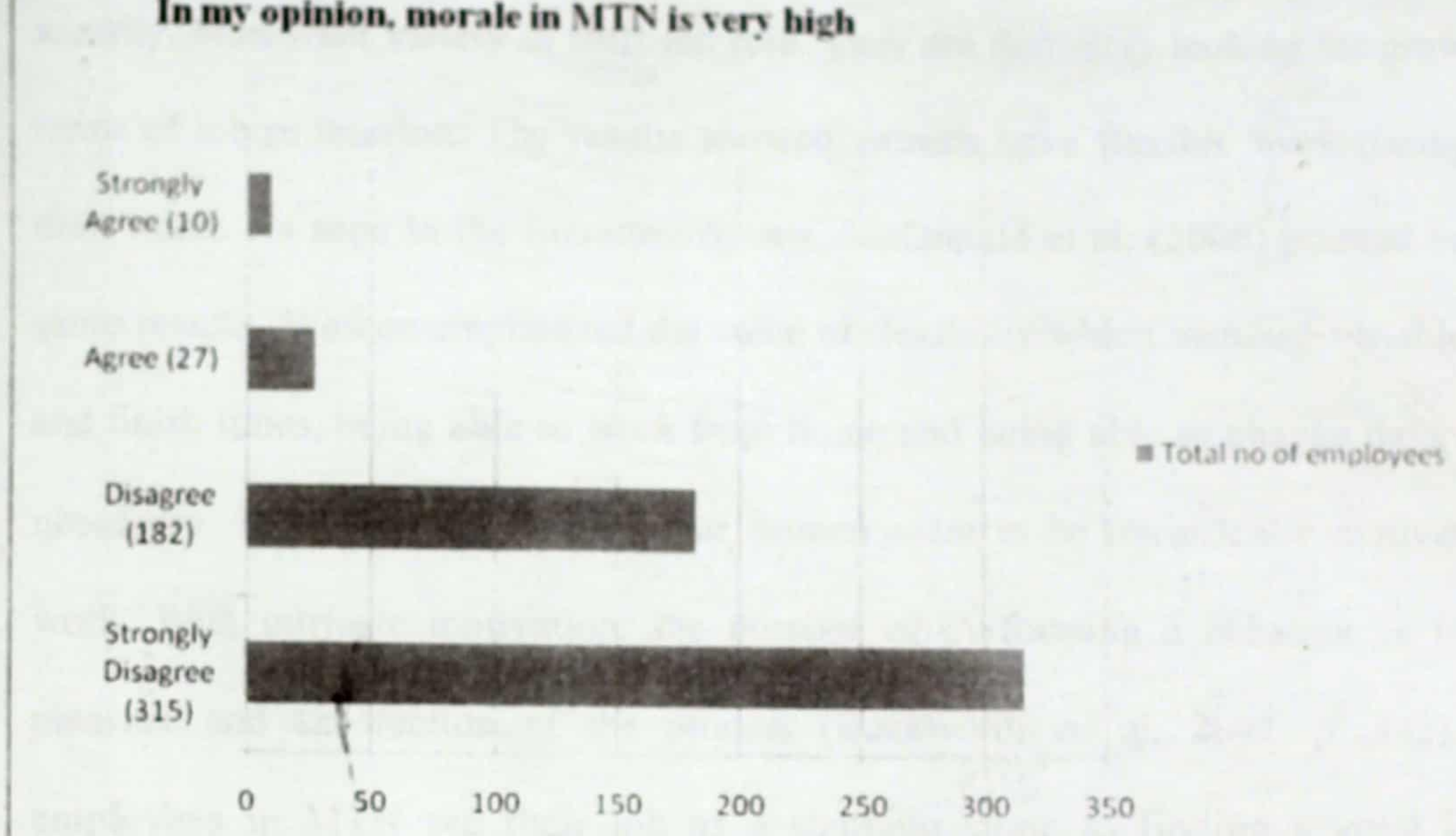
Response rate: 98.38%



Response to the statement: I will recommend MTN as a 'great place to work'
(Source: Internal Report, 2007)

In a way, figure 4.2.8 sums up the entire secondary data. Ninety-three per cent (93%) disagreed that the morale of the company is very high, which includes 61% who strongly disagreed to that statement that is 497 out of 534 respondents.

Figure 4.2.8 Response rate: 98.92%



Response to the statement: In my opinion, morale in MTN is very high

(Source: Internal Report, 2007)

So, what is it that we understand from the secondary data?

We see that the morale is low. Because its employees do not believe that MTN is fair. One of the reasons could be the lack of transparency. The employees do not feel that MTN takes any initiatives to retain the good employees nor that the right people get promoted.

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4.3 DISCUSSIONS OF RESULTS

How varied are motivational factors of MTN's employees based on gender and age?

Looking back at table 1 which shows the results of 550 surveys conducted in 1992, we see that good wages, full appreciation of work done and job security take the top 3 positions. From this research, we again see good salary and job security take the top 2 positions. Employees are attracted to work in MTN because of good salary and job security. Men want variety in their job role. They are definitely looking for growth in terms of job promotion. The results showed women have flexible work timings on their mind. As seen in the literature review, McDonald et al. (2006) pointed out the same results. Women emphasized the value of flexibility which included variable start and finish times, being able to work from home and being able to change days when necessary. Also, the fact remains that women seem to be intrinsically motivated to work. With intrinsic motivation, the purpose of performing a behavior is for the pleasure and satisfaction of the process (Buckworth et. al. 2007, p. 443). The employees in MTN see their job as a stepping stone to finding a good job in another company (figure 5). They value the training provided by this organization as a means of increasing their employability.

The findings did not show any noticeable difference in the motivational factors as we move across the ages. What was interesting is the fact that the Table 2 from the 1992 survey in the literature review also could not find any variation.

Are MTN's part-time employees looking for short-term career/job? And do they feel that they have less growth opportunities?

What needs to be kept in mind is that the part-time employee interviewed (Interviewee1) and all the 4 questionnaires received from part time employees were women. So, it's difficult for the researcher to decide whether this data should be looked at as coming from a woman or a part-time employee.

As seen from the Table 2 of the 1992 survey, our data also points towards the direction that shows part-time employees reporting higher positive significant preferences for interesting work and good working environment. They are internally motivated.

The current situation in MTN

In light of the findings, the conclusions of the two tests conducted by Wegge et al. (2006) on call centre employees become all the more significant which found a strong correlation between the strong psychological attachment of employees to their organization and work motivation and well-being. In MTN, the main concern is: lack of communication. This situation is evidence in the literature on the service gap model. The expectation of customer service employees' is not being met in terms of dissemination of information that particularly concerns affect them. Lack of communication might cause employees to perceive that MTN is unfair – that the 'right' employees are not promoted. They do not realize the significance of the various programs and measures being taken by the organization. They see it as nothing but 'grand schemes' (as quoted by Interviewee 3). All of these impacted negatively and cause employees to feel 'disconnected' with the company, a situation uncovered by

Zeithml, and Bitner (2000). Berry and Parasuraman (1993) which has culminated in the fifth gap in the 'gap' model as captured in the reviewed literature on service quality especially the fifth gap which is about the expected and the experienced service.

CHAPTER 5

SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.0 SUMMARY

The aim of this research was to understand the motivational factors of the internal marketing activities that affect customer service employees of MTN and whether it differs based on sex, age and employment status (full time/ part time employee). As shown in the literature, there is a strong argument in understanding the motivational factors if we are looking at gaining a better perspective on an organization's policies and procedures. This would also explain the attrition rate that has increased during the past few years. The research questions were guided by Hiltrop's (1999) suggestion on how a firm can attract and retain talent. Table 2.4 in the literature review listed the variables that considered in this study. Grounded theory fitted with this kind of research because it provided deep consideration of the variables - this meant starting the research without making any assumptions and looking for hidden depths and connections. Triangulation of data further strengthened this research. Data was collected from three sources: self-administered questionnaires, 3 interviews and Internal Report, 2007 - a past conducted survey in the form of secondary data. Table 3.1 in the methodology justified the questions asked in the questionnaire and during the interviews.

Some of the major drawbacks of this research are the low response from questionnaires distributed which meant that it would not lend itself to statistical analysis and that the 3 interviewees were handpicked by the company although with my guidance. A focus group of employees from wider demographics would have been a good option. Also all the

responses (questionnaires and interview) from part-time employees have been from women which makes it difficult to decide whether to look at the response from a woman's view or a part-time employee's view. The survey report has very high validity as the response rate to some questions was as high as 99%. However, the fact that this survey had not broken down the numbers to sub-groups according to various demographics limited its usability. However, in spite of all these drawbacks, these findings are strong as triangulation shows that these three independent sources converge or at least, do not oppose each other (Decrop 1999: 157).

5.1 RECOMMENDATIONS

The findings of this study have several managerial implications. The results of this research enable managers including those of retail outlets to better understand the nuances of managing their employees to achieve market success. It is recommended that all managers of a firm have a role to perform if internal marketing could be effective. In particular the need for managers to balance their formal behaviour with the more informal behaviour towards employees is apparent, as is the need to collect, disseminate and act upon intelligence about the wants and needs of employees, the factors influencing employment in the industry and the employment offerings of competitors. It is only when this is done with constant review of wages to be commensurate and motivating in line with Stacy Adams Equity theory, will MTN stamped out favouritism.

It behoves on management to periodically renew employee contracts well ahead of the expiration of these contracts, vary job roles among the men which will ensure and encourage customer service employees about their job security.

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Similarly, management should institute flexibility work timings for women to enable them contribute their widows mite to corporate productivity while maintaining their traditional womanhood roles. MTN as a communication entity should develop and incorporate working through the information and communication technology media, to ensure that women can work from even homes. This is important in order to overcome the negative perception of women in paid jobs which tends to affect family life and social cohesion in the Ghanaian society.

Furthermore, there is the need to efficiently integrate part time employees in terms of rewards and promotion which is likely to enhance their motivation, job security and ultimately higher productivity. This will aid word of mouth recruitment which has been cited as a top recruitment method.

Finally, MTN needs to communicate its vision more clearly, something that clarifies the direction in which an organization needs to move (Kotter 1995: 63). Hiltrop's (1999) suggestion on creating an ability to attract and retain talent speaks about designing challenging and career enhancing work experiences, making line managers accountable for the people they need and providing opportunities for learning and self-development integrated with career planning and mentoring. How is MTN intending to do this? And how would they communicate what is being offered in terms of job promotion and development? It is the role of the managers to answer these questions to ensure that all available options and choices are identified, and that the choices made take account of both short- and long-term interests of all their stakeholders - whether these are shareholders, employees, the managers themselves or the community at large. The worst managers may not be those who make poor choices; it may be those who fail to recognize that there are choices to be made (Burnes 2000: 508).

The researcher believes that it is necessary to start improving ones customer service practices by focusing on the HIT factor – Honesty, Integrity and Transparency.

Indeed, if the premise of internal marketing is the internal relationships between the organization and its employee groups is anything to go by, then the concerns of the respondents suggests a more meticulous and prudent internal marketing plan. This is discernible from the data analysed in this study. One cannot help but to agree that internal marketing (motivational aspect) impacts on customer service employees who must operate effectively before the firm can be successful in achieving its goals regarding its position in the external markets by way of market share and growth.

5.2 CONCLUSION

The findings of this study matched with what has been found in the literature. Men wanted growth in terms of job promotion. They were looking for variety in their job role. Women and part timers - both wanted flexibility in their work schedule. These two sub-groups seem to be internally motivated. Salary and job security were the top two reasons for employees to work for MTN. There was no conclusive difference among the motivating variables as we moved across the ages. Majority of them did see their job as a stepping stone to finding a good job in other companies. As pointed out by the labour trends survey (2002) in table 3, word-of-mouth recruitment tops the list on how the majority of new hires got their jobs. In MTN, it appears the workers are not properly integrated through internal marketing programmes. We have 58% of the employees who disagreed that they will recommend MTN as a great place to work (table 14). That's one very important source of recruitment being used ineffectively as a result of how the company's internal marketing program is administered.

MTN's internal marketing efforts also did not bridge the gap between the lower and the upper management. The findings showed that there is disconnectedness between the employees on the floor and the upper management. The tests conducted by Wegge et al. (2006) on call centre employee studying the work motivation show how crucial this is especially on a job where there are limited things that one could do with the motivating potentials of work (e.g., task variety, task significance, task completeness). Kotter (1995) in one of his best known articles "Why transformation efforts fail" gives not establishing enough a great sense of urgency and not creating a powerful guiding coalition as two of the eight reasons on why transformation efforts fail in organizations.

MTN's internal marketing programmes impacted customer service employees' through good salary, job security as the most important motivational variables identified to be of great concern to the employees. The study also found that absence of favouritism, flexible work timings in the case of women, growth in job role or promotion and communication between management and customer service employees are other identified crucial factors to be considered in any meaningful internal marketing plan. These findings are my modest contribution to the knowledge capacity in the area of internal marketing and customer service. It is in this light that I agree with Christian Gronroos (2007) that "it should always be remembered that what counts is quality as it is perceived by customers".

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APPENDICES

EMPLOYEE OPINION SURVEY QUESTIONNAIRE

This questionnaire is to elicit responses to aid the researcher to fulfil the requirements of his Masters Degree programme. It is for academic purposes only for which your anonymity protection is guaranteed.

SECTION A

To help classify answers and to make statistical comparisons, I would appreciate some personal information about you. **Please choose by ticking the appropriate option**

1. How long have you worked in MTN?

Less than 1 year ☐ 1-2 years ☐ 2-3 years☐ 3-4 years☐ 4-5 years☐ more than 5 years ☐

2. Indicate your employment status:

Full time employment☐ Part time employment ☐

3. What is your age?

☐ Below 20years ☐ 20-29 years ☐ 30-39 years☐ 40-49 years ☐ 50 years above

4. Indicate your gender (by ticking)

☐ Male ☐ Female

5. What is your marital status?

☐ Married (includes civil partnerships) ☐ Single (includes divorce and widowed)

6. Do you have any child less than 18 years staying with you?

Yes ☐ No ☐

SECTION B

Please could you indicate your level of agreement or disagreement with each statement below by indicating whether you: Strongly Agree **(SA),** Agree **(A),** Neutral **(N),** Disagree **(D),** Strongly Disagree **(SD). Please choose the appropriate response/answer.**

7. There is nothing wrong with people changing their jobs every 1-2 years

SA☐ A☐ N ☐ D☐ SD ☐

8. I would like to have flexible working hours

SA☐ A☐ N ☐ D ☐ S D☐

9. Part time employees have fewer chances of promotion in the company

SA ☐ A ☐N☐ D ☐ SD ☐

10. The training programs and the constant learning is a great advantage of working in MTN

SA ☐ **A** ☐ **N** ☐ **D** ☐ **SD** ☐

11. My job tends to get very repetitive

SA ☐ **A** ☐ **N** ☐ **D** ☐ **SD** ☐

Complete the following sentence by choosing options 'A' or 'B'

12. I would prefer a job_____

A. with a lower starting salary now but good chances of promotion after working with the company for 2 years

B. with a higher starting salary now but unsure about the future career opportunities (in terms of job promotion)

Complete the sentence by choosing the appropriate option (you can choose as many options as you want)

13. My job at MTN

☐ offers me a bright future (in terms of job promotion)

☐ helps me develop new skills through training and learnin

☐ provides me a competitive salary

☐ increases my employability(will help me get a better job in other companies)

Others, please specify_____

Rank these options from 1 to 6 with 1-Most important and 6-Least important

14. The important things that I look for in a job are:

☐ Job security

☐ Rewards and recognition for good work done

☐ Good salary

☐ Flexible work timings

☐ Developing new skills through training and learning

Choose the appropriate option

15. Have you worked before joining MTN (for more than 6 months?)

☐ Yes ☐ No If No, continue from section C

If yes, why did you leave that job? (You can choose more than one option)

☐ Job security

☐ Good salary

☐ Job promotion

☐ Flexible work timings

Others, please specify _____

SECTION C

Complete the sentences in your own words

16. If I was given 10,000 GH Cedi, I would _____

_____

_____

17. If there is anything that I could change about my job/company, it will be

_____

_____

_____

18. Some of the things I liked about my job are

_____

_____

_____

19. What will be your rank in the next two years (in terms of promotions).

_____

_____

THANK YOU SO MUCH FOR YOUR TIME, I APPRECIATE IT

PHYTOCHEMICAL COMPOSITION OF *IPOMOEA BATATAS* AND *MORINGA OLEIFERA* LEAVES AND CRACKERS FROM UNDERUTILISED FLOURS.

BY

DEBORAH OWUSU (BSc HONS)

A THESIS SUBMITTED TO
THE DEPARTMENT OF BIOCHEMISTRY AND BIOTECHNOLOGY
FACULTY OF BIOSCIENCES,
COLLEGE OF SCIENCE,
KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF

MASTER OF SCIENCE (MSC) DEGREE

FEBRUARY, 2008

DECLARATION

I hereby declare that this thesis is the result of my own work except references cited that have been duly acknowledged. It has never been submitted for the award of any degree.

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Deborah Owusu (PG 121705) ..... DyOwusu .....

Supervisors

Dr. Mrs. Ibok Oduro (Head of Department) .....

Prof. William. O. Ellis .....

DEDICATION

This work is dedicated to my parents Mr. E. K. Owusu and Mrs M. P. Owusu.

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PUBLICATION NOTICE

This thesis contains the following published work:

Nutritional Potential of two leafy vegetables: *Moringa oleifera* and *Ipomoea batatas* leaves.

Published in: Scientific Research and Essay Vol. 3 (2), pp 057-060, 2008.

ABSTRACT

Great emphasis is being placed on the consumption of food that will not only provide nutrients to the body but also help in the prevention of diseases such as cancer, cardiovascular diseases, and age-related macular degeneration as well as malnutrition. People are being encouraged to eat fruits and vegetables which have antioxidative and bioactive compounds that help prevent molecular damage caused by oxidation. *Ipomoea batatas* and *Moringa oleifera* are two indigenous vegetables whose nutritional potential though felt in other parts of the world are not known in Ghana. Thus the need for the analysis for the nutritional and phytochemical potential of the new varieties of these vegetables found in Ghana as well as their use in product development. Phytochemical analysis of the leaves was carried out using standard methods of analysis. The results obtained showed that *Moringa oleifera* had higher levels of crude protein, crude fibre, crude fat, iron, calcium and beta-carotene. The *Ipomoea batatas* samples, however, had higher levels of crude ash, total carbohydrate, total calorie, moisture and total phenolics. Cream cracker were developed from cassava and sweetpotato flour incorporated with these leaves using wheat flour as the control. Sensory evaluation of the cream crackers developed showed that they have good sensory properties and since the cassava and sweetpotato flour crackers do not contain gluten, they can be consumed by those who are gluten intolerant.

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CHAPTER ONE

1.0 INTRODUCTION

People of all ethnic backgrounds, the old and young, rich and poor enjoy taking snacks at various times. It is reported by Howell (2005), that now more than ever consumers' interest in healthier snacking options, resulting in significant innovation related to whole grain and nutritious crackers has increased. Consumers are slowly nibbling their way back to a more typical, if somewhat more health conscious, pattern of consumption in crackers.

As a child grows, snacks become important since he/she cannot wait many hours between the regular schedule of meals (Satter, 1987, Bobroff, 2004). Therefore parents and caregivers should provide young children with snacks that consist of nutritious foods appropriate for the child's age that make a significant contribution to the nutritional quality of the diet. Many teenagers have high calorie needs, especially during growth spurts, and snacks chosen by teenagers often are high in fat and/or sodium, and low in key nutrients such as iron, calcium, vitamin A, vitamin C, and folate (Rolfes *et al*, 1998). Teenagers need to know how to balance low nutrient-dense meals with meals and snacks rich in vitamins, minerals, and phytochemicals from whole grains, fruits, vegetables, and legumes (Position of the ADA, 2000). Gluten intolerance, a genetic condition affecting about one in 200 people in the world makes people intolerant to gluten (Gluten Intolerance and Celiac Disease, 2006). Since there is up to date no medication against this condition, the best treatment is a gluten free diet (Feighry, 1999; Sheasby, 2001; Corcoran, 2006). Since individuals on any avoidance diet are at risk of developing deficiencies of micro-nutrients

(Steinman, 2007), healthy snacks in the form of enriched crackers can be helpful in preventing nutrient deficiencies.

It is reported (Consumer Reports on Health, 1998; Palmer, 2005; Martinez and Martinez. 2007), that researchers are convinced that the nutrients in fruits and vegetables do more than just prevent deficiency diseases such as beriberi or rickets with the most publicized finding being that certain vitamins or vitamin precursors in produce, notably vitamin C and beta-carotene, and polyphenols are powerful antioxidants. Antioxidants help prevent molecular damage caused by oxidation; this protection may help fend off many diseases including cancer, cardiovascular diseases, and macular degeneration (Islam *et al*, 2002).

Ipomoea batatas leaves have been proven by Islam *et al* (2002) to be an excellent source of antioxidative polyphenolics compared to other commercial vegetables, and though consumed in Asia and some sub-Saharan countries (Duke, 1983), have generally been an underexploited green vegetable as observed by Messiaen (1994). *Ipomoea batatas* listed by Abbiw (1990) as one of the vegetables consumed by all ethnic groups in Ghana is not produced on a large scale and it must be noted that only the storage roots are consumed in large quantities. Also there is no information about the nutritive and phytochemical potential of the new varieties of *Ipomoea batatas* (Sauti, Ogyefo, Apomuden, Otoo, Hi Starch, Okumkom, and Santom Pona) to be introduced to farmers in Ghana. Yoshimoto *et al* (2002) reported that the sweetpotato leaf is considered to be tougher in terms of texture than other leafy vegetables and therefore is less popular with consumers (Woolfe, 1992). As a result, there is the need

for the development of products that will be easily accepted by the consumer and have the necessary nutrients.

Leaves of *M. oleifera* can be an extremely valuable source of nutrition for people of all ages. In some parts of the world such as Senegal and Haiti, health workers have been treating malnutrition in small children and pregnant and nursing women with Moringa leaf powder (Price, 1985). Fuglie (2005), reported that 8 g serving of dried leaf powder will satisfy a child of 1-3 years with 14 % of the protein, 40 % of the calcium, 23 % of the iron, and nearly all the vitamin A that the child needs in a day. A 100 g portion of leaves could provide a woman with over a third of her daily need of calcium and give her important quantities of iron, protein, copper, sulphur, and B-vitamins. The Moringa is a fast growing tree that does well even in arid, sandy conditions, grows to four meters, and bears fruit within the first year of growth (Fuglie, 2001).

Unfortunately, though the benefits of *M. oleifera* and *I. batatas* are being felt in some countries of the world such as Senegal and Haiti and Phillippines, that is not the case in Ghana. The leafy vegetables given *importance* in relation to consumption do not include *Ipomoea batatas* and *Moringa oleifera* leaves (Blay, 2004). Crackers, though enjoyed by all are not highly nutritious. There is therefore the need to enrich crackers to provide more nutrients for the consumer, using the underexploited vegetables.

Therefore the aims of this project were:

- To determine the phytochemical composition of *Ipomoea batatas* and *Moringa oleifera* leaves
- To develop crackers from alternative flour sources.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 EMPHASIS ON HEALTH

Recently, great emphasis is being placed on consumption of food that will not only provide nutrients to the body but also help in the prevention of diseases. People are being encouraged to eat food not just to satisfy their hunger but to maintain and improve their health. As a result of this, research is continually being done in the determination of the nutrient content of fruits and vegetables. Several authors (Consumer Reports on Health, 1998; Palmer, 2005; Martinez and Martinez. 2007), report of the conviction of researchers that the nutrients or bioactive compounds in vegetables and fruits do more than just prevent deficiency diseases such as beriberi or rickets. The most widely publicized finding is that certain vitamins or vitamin precursors in produce, notably vitamin C and beta-carotene, are powerful antioxidants.

Antioxidants help prevent molecular damage caused by oxidation; this protection, according to Consumer Reports on Health (1998), may help fend off not only cancer, stroke, and coronary heart disease but also arthritis, asthma, cataracts, and macular degeneration, the leading cause of blindness after age 65 years. "Bioactive compounds" are extra nutritional constituents that typically occur in small quantities in foods. They are being intensively studied to evaluate their effects on health. The impetus sparking this scientific inquiry is the result of many epidemiologic studies that have shown protective effects of plant-based diets on cardiovascular disease (CVD) and cancer (Kris-Etherton *et al*, 2002). Surh (1999) agrees with Kris-Etherton *et al* (2002) and goes on to report of many bioactive compounds that have been

discovered and that these compounds vary widely in chemical structure and function and are grouped accordingly. Their beneficial effects are attributed partly to the presence of numerous polyphenolic compounds, which display antioxidant and free radical scavenging properties.

Radicals are defined by Guan and Whiteman (2004) as chemical species with one or more unpaired electrons. Free radicals are radicals that have moved out of the immediate molecular environment of their generation (Guan and Whiteman, 2004). These free radicals are generated continuously in the human body as by-products of normal metabolism such as the reduction of molecular oxygen in mitochondria during cellular respiration, and degradation of fatty acids and other molecules in peroxisomes (Guan and Whiteman, 2004). Free radicals and oxidants can trigger lipid peroxidation, as well as the oxidation of proteins and DNA, causing extensive damage to body cells. They are implicated in some diseases such as Alzheimer's disease (Athar, 2002), cancer (Szweda *et al*, 2002), vascular disorders (atherosclerosis, diabetes, hypertension) (Chen *et al*, 2003) and accelerating the aging process (Szweda *et al*, 2002). Increasing the level in foods of highly active radical scavenging compounds is important for maintaining a balance between oxidants and antioxidants in the body and for eliminating oxidative stress. It is also clear from Guan and Whiteman (2004) that most of the dietary antioxidants have low or minimal toxicity, and that intake can be increased without adverse effects.

Phenolic compounds have the ability to scavenge free radicals and to contribute significantly towards antioxidant activities of vegetables and fruits. Plant phenolics comprise a large variety of substituted phenolic compounds that give colour and

astringent taste to foods and according to Fennema (1996) the glycosidic flavonoids are the largest groups of compounds among the plant phenolics. Phenolic acids such as caffeic, ferulic and gallic acids and their derivatives are abundant in many plants and they include anthocyanin pigments, yellow flavones, flavonols, chalcones and isoflavones. Phenolic compounds, including their subcategory, flavonoids, are present in all plants and have been studied extensively in cereals, legumes, nuts, olive oil, vegetables, fruits, tea, and red wine. According to several authors (Huang and Ferraro, 1991; Hagerman *et al*, 1998; Kaul and Khanduja, 1998), polyphenolics have attracted special attention because they can protect the human body from the oxidative stress which may cause many diseases.

Recently, health workers and scientist are encouraging the intake of fruits and vegetables with high polyphenolics and therefore high antioxidant content (Best, 2005) because these, as well as nutrients, are best absorbed and used by the body when they are derived from natural sources (plants and animals). These are present in naturally occurring complex compounds, and not as separate compounds as formulated in pills (Sambou, 2005). Fuglie (2005) stated that among the wide range of green leafy vegetables, Moringa is the richest source of β-carotene (pro-vitamin A), with sweetpotato leaves also having appreciable amounts of β-carotene (Yoshimoto, 2001). According to our present knowledge, Moringa (leaves, seeds, pods) contains specific plant pigments with demonstrated potent antioxidant properties such as the carotenoids – lutein, alpha-carotene and beta-carotene, xanthins and chlorophyll; contains powerful antioxidant vitamins such as vitamin C, E; and has essential micronutrients with antioxidant activity or directly linked to this process: selenium and zinc. Moringa also contains other phytochemicals with known

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powerful antioxidant ability such as kaempferol, quercetin, rutin and caffeoylquinic acids (Fuglie, 2005).

Ipomoea batatas leaves, according to Islam *et al* (2002) and Komaki and Yamakawa (2007), are also an excellent source of antioxidative polyphenolics such as caffeoylquinic acid, anthocyanins, as well as beta-carotene. As reported by Marcu (2005), excess consumption of the leaves does not lead to toxicity since the polyphenols can be eliminated or deposited in the fat tissues. The plant phenols, because of their diversity and extensive distribution, are the most important group of natural antioxidants, and they contribute to the organoleptic and nutritional qualities of fruits and vegetables (Fennema, 1996; Islam *et al*, 2002).

2.2 SUMMARY OF SOME PHYTOCHEMICALS FOUND IN THE LEAVES

Beta-Carotene: Beta-carotene is strong against singlet oxygen, can stimulate DNA repair enzymes, gives better cornea protection against UV light than lycopene and can boost the activity of Natural Killer (NK) immune cells (Best, 2005).

Flavonoid Polyphenolics: Best (2005) also describes flavonoids as flavone-like substances that are usually antioxidants and sometimes anti-inflammatory. Flavonoids scavenge free radicals by forming a stable radical that can react with another flavonoid radical to produce two non-radicals.

Anthocyanins: Anthocyanins are water-soluble glycosides and acyl-glycosides of anthocyanidins. They make cherries & strawberries red, blue berries blue and sweet potato leaves red. Anthocyanins have anti-inflammatory effects and protect endothelial cells from oxidative damage (Best, 2005).

Isoflavones: Isoflavones are named as some of the phytochemicals found in sweetpotato and Moringa leaves as well as in other legumes, parsley and grains by. Best (2005). They elevate HDL cholesterol (good cholesterol) and lower LDL cholesterol (bad cholesterol). Also, they are potent antioxidants against superoxide and hydrogen peroxide, have estrogenic-like qualities (phytoestrogen), may reduce menopausal symptoms, prevent bone resorption (osteoporosis) in post-menopausal women, may prevent breast cancer, inhibit prostate cancer cells by 30%, and inhibit tyrosine kinases involved in tumorigenesis.

Chlorogenic Acid: According to Best (2005) this phytochemical is very high in sweet potato tops, found in the flesh of grapes, along with ellagic acid and is most frequently an ester of caffeic acid. Caffeic acid reduces mutagenicity of polycyclic aromatic hydrocarbons, is a major contributor to the antioxidant activity of coffee and can regenerate oxidized Vitamin E.

Lycopene: Lycopene gives the red colour of tomatoes, watermelon, pink grapefruit, guava and papaya. Light and heat converts the trans form to the cis form, which is more bioavailable. Lycopene binds tightly to fibres, is freed by high heat, not soluble in water but more soluble in oil. It is classified as one of the powerful antioxidant which reduces damage to DNA and proteins and gives better skin protection against UV light than beta-carotene by Best (2005). Accounting for nearly half the total carotenoids in the blood serum, lycopene concentrates in the skin, testes, adrenal and prostate where it protects against cancer.

Alpha-Carotene: Alpha –carotene is ten times more anti-carcinogenic than beta-carotene, enhances release of immunogenic cytokines and helps in improvement of vision.

Lutein and Zeaxanthin: Lutein and zeaxanthin constitute about half of all carotenoids in the retina, give corn, avocado and egg yolk a yellow colour. Lutein and zeaxanthin are the only carotenoids in the macula of the eye (Fig 2.4). They protect the eye from macular degeneration and cataracts by absorbing damaging blue light (Best, 2005 and Sahelian, 2007). Lutein and zeaxanthin are present in nearly equal amounts in the macula.

Chlorophyll: Chlorophyll is the most abundant pigment in plants as well as the principal light-absorbing pigment in photosynthesis (Taiz and Zeiger, 2002 and Best, 2005). It has a porphyrine ring similar to heme (of haemoglobin), but with a magnesium (not iron) central atom. It is not water soluble and forms tight molecular complexes with some carcinogens: aflatoxin-B1, polyaromatic hydrocarbons (tobacco smoke) & heterocyclic amines (cooked meat).

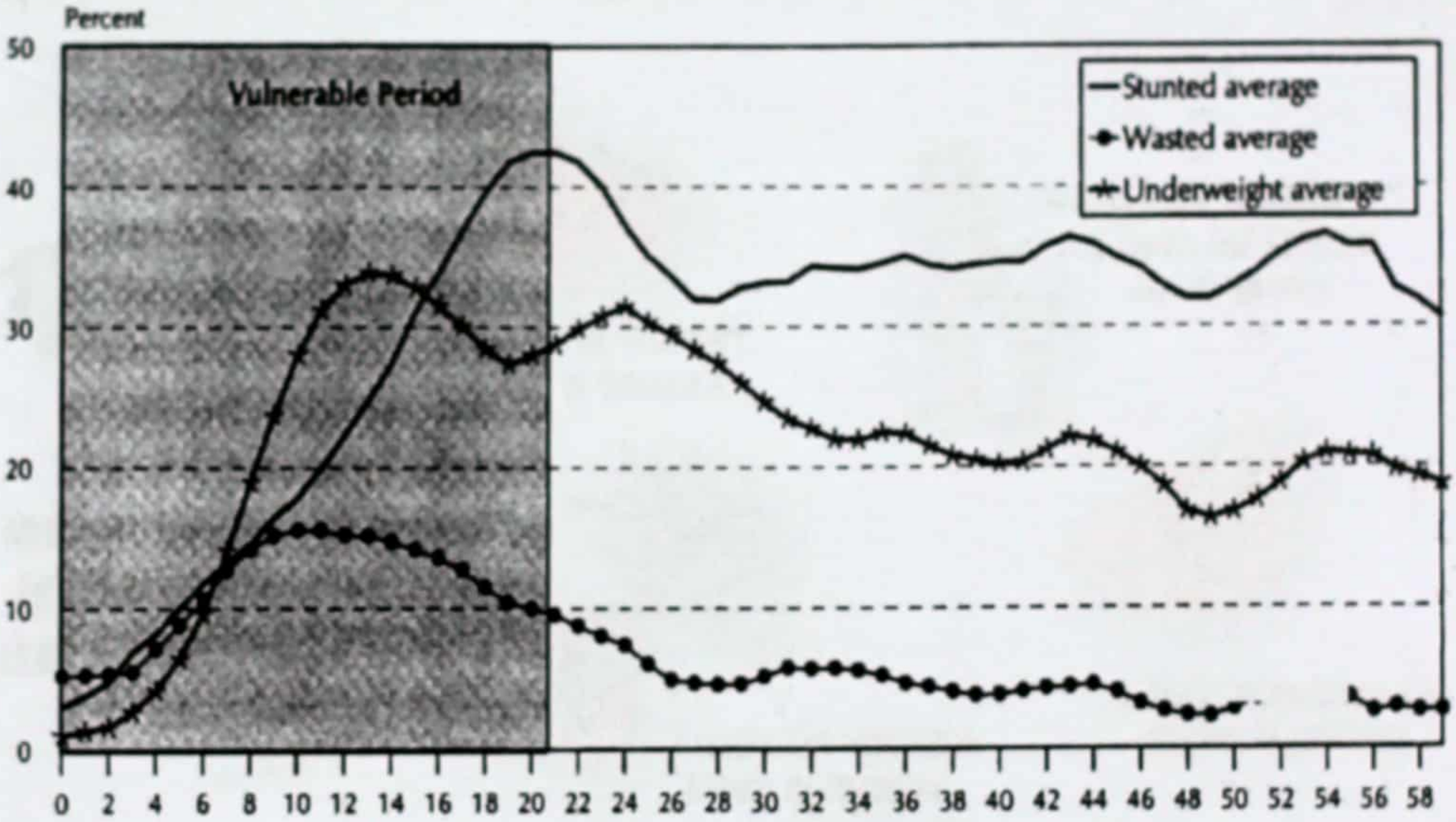
2.3 BENEFITS OF THE LEAVES

2.3.1 *FIGHT AGAINST MALNUTRITION*

Malnutrition in its various forms (kwashiorkor, beriberi, anaemia, and scurvy) is reported as a major factor in the high rates of infant mortality as well as ill health in adults in the tropics (Moringa oleifera: The Miracle Tree, 2000). The former United Nations Secretary-General, Kofi Annan, lamented that Africa is the only continent where child malnutrition is getting worse rather than better (Fuglie, 2005). Black (2003) agrees that malnutrition/ micronutrient deficiencies are now recognized as an important contributor to the global burden of disease. Iron deficiency is attributed to the cause of about 800,000 deaths and 2.4 % of the global burden of disease. The Ghana Statistical Service (GSS) reported in the 2004 Ghana Demographic and Health Survey (GDHS) that children under the age of five years and women of reproductive

age are most vulnerable to malnutrition. It states that micronutrient deficiency is a major threat to maternal health as it contributes to low birth weight, lowered resistance to infection, poor cognitive development, and decreased work capacity. According to the 2004 GDHS (Fig 2.1), 30 percent of children under five are stunted and 11 percent severely stunted. Seven percent of children under five are wasted and 1 percent severely wasted. Weight-for-age results show that 22 percent of children under five are underweight, with 5 percent severely underweight.

Stunting, Wasting, and Underweight by Age, Ghana



Note: *Stunting* reflects chronic malnutrition; *wasting* reflects acute malnutrition; *underweight* reflects chronic or acute malnutrition or a combination of both. Plotted values are smoothed by a five-month moving average.

GDHS 2003

Fig 2.1 Malnourishment in children in Ghana (GDHS, 2004)

Considerable investments have been made by governments and aid agencies to promote solutions to this problem. Yet a major problem or drawback of many of the

approaches used is the dependence on imported solutions and personnel from outside the country and because of these setbacks as stated in Moringa oleifera: "The Miracle Tree" (2000), progress can quickly dissipate once the programme funding finishes.

Interest is growing in the use of *Moringa oleifera* and *Ipomoea batatas* in addressing malnutrition in developing areas of the world. Church World Service (CWS), in a report by UNESCO in "Improving nutrition with Moringa 'miracle' trees in Senegal" (2003), initiated a programme in Senegal which has demonstrated that the highly nutritious leaves of the Moringa plant are very effective at helping prevent malnutrition. The nutritional value of Moringa is compared to other produce and has been shown to be richer in micronutrients. Figure 2.2 shows the relationship.

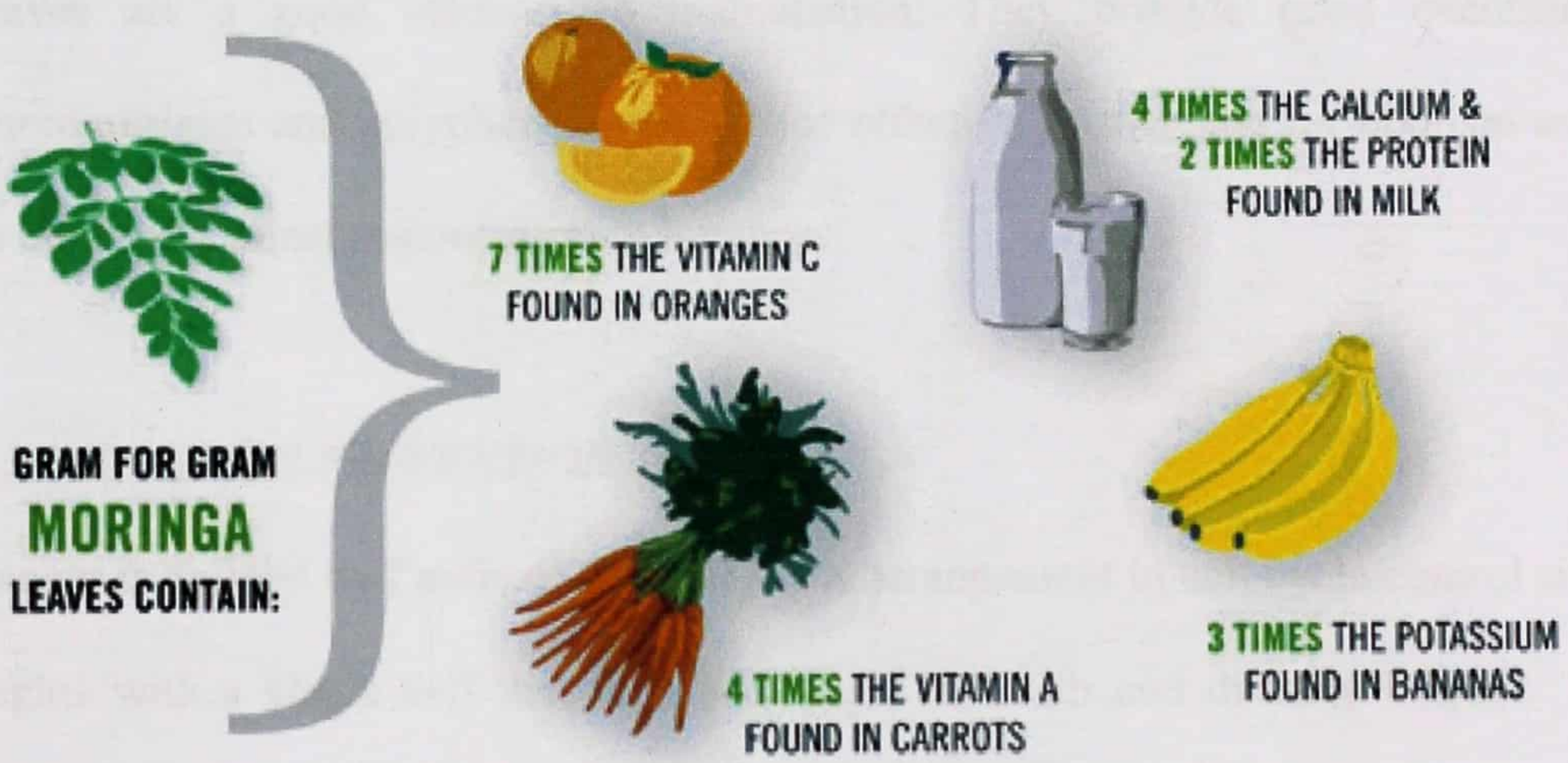


Figure 2.2 Nutritional value of Moringa leaves (Hsu *et al*, 2006).

Fuglie (2005) states that 8 g serving of dried leaf powder will satisfy a child of 1-3 years with 14 % of the protein, 40 % of the calcium, 23 % of the iron and nearly all the vitamin A that the child needs in a day. As little as 20 grams of dried leaves would provide a child with all the vitamins A and C he needs. It is fast growing and

drought resistant, remaining green when other leafy vegetables are out of season. This makes it available all year round as a supplement to the diet.

Though sweetpotato leaves are not new discoveries, and are highly nutritious, work has not been done on the new varieties found in Ghana to know their nutritional profile. Indigenous tropical vegetables including sweetpotato greens are reported by Woolfe (1992) as having low prestige in many parts of the world, being regarded as 'poor man's salad' and as such are less desirable than other vegetables. This has made the acceptability of the vegetable low in most areas of the world where they are grown, such as China, New Guinea, Sierra Leone, Tanzania and Liberia (As-Saqui, 1982). *Moringa oleifera* and *Ipomoea batatas* because of their highly nutritious leaves are a good solution to malnutrition. They provide good quantities of micronutrients and polyphenols needed for effective growth and metabolism as well as the fight against malnutrition in humans.

2.3.2 CANCER PREVENTION

Cancer is defined by Lewis *et al* (2002) as a derangement in cell cycle control since it begins with a single cell that breaks through its death and division control. These authors go on to explain that two major genes contribute to causing cancer, oncogenes and tumour suppressor genes. Oncogenes are versions of genes that normally trigger cell division, but they are over expressed and accelerate the cell cycle allowing the excess new cells to form a tumour. Tumour suppressor genes produce a protein product that normally prevent a cell from dividing or promote normal cell death. Inactivation or removal of a tumour suppressor gene can cause cancer. Healey, (2006), agrees with Lewis *et al* (2002), adding that cancer is also caused by

carcinogens (cancer causing substances) such as tobacco smoke; ultraviolet radiation from sunlight; industrial chemicals, viruses and genetics. Since cancer cells divide more than the cells from which they derive, when given sufficient nutrients and space, they divide uncontrollably and eternally (Lewis *et al*, 2002).

Fig 2.3 shows that most countries in the world have cancer cases of more than 151 per 100,000 people. Developing countries can learn from past mistakes by encouraging citizens to increase their intake of vegetables such as *Ipomoea batatas* and *Moringa oleifera* leaves.

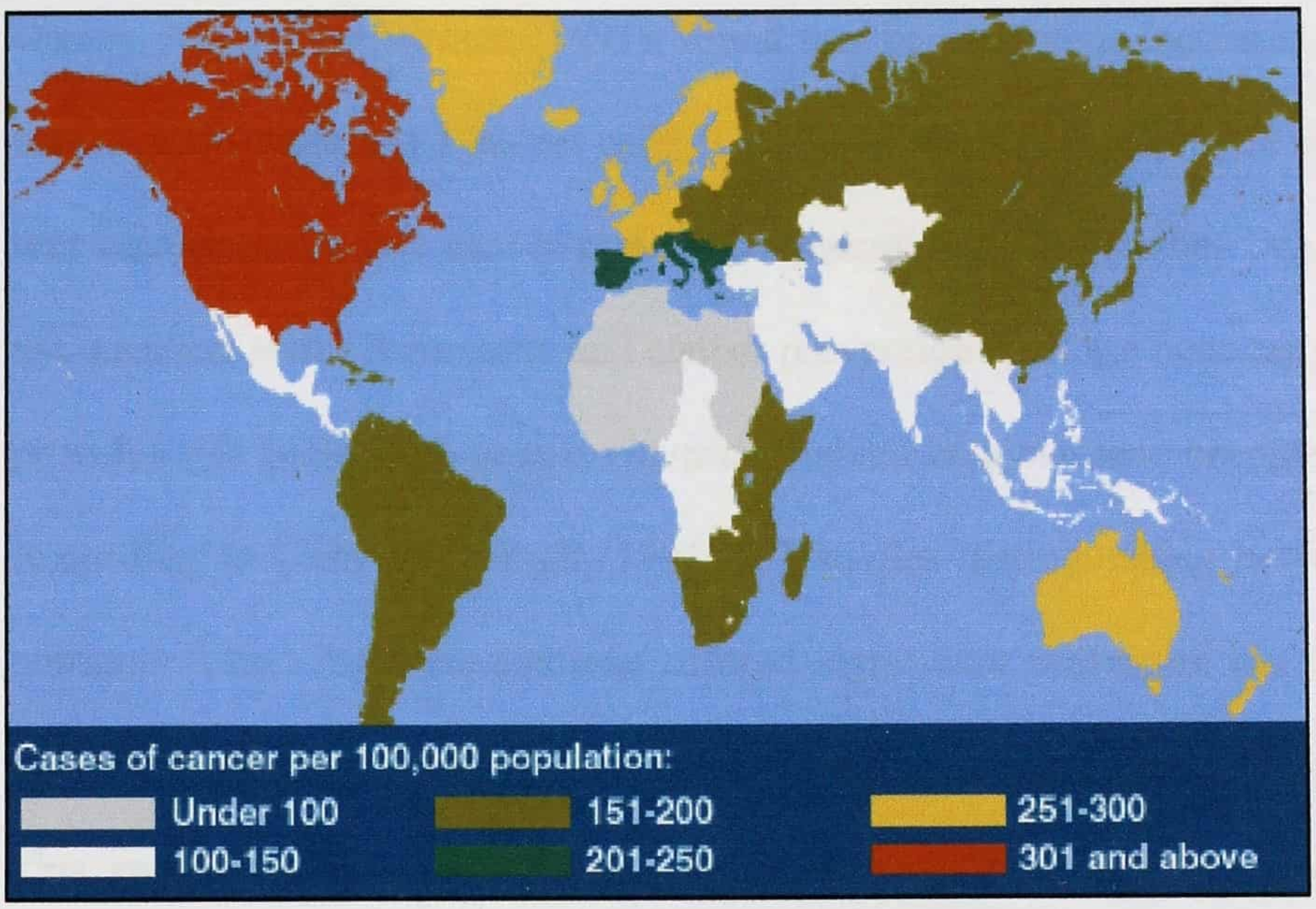


Fig. 2.3 Cancer cases worldwide (Worldwide Cancer Cases 'Double', 2005).

In the search to conquer this disease worldwide, scientists have noticed that the increased consumption of vegetables such as Moringa and sweetpotato leaves (which contain phenolic compounds) is helpful. Epidemiological studies have demonstrated the protective effects of vegetable consumption on human health. Many polyphenolic compounds have an anti-carcinogenic (anti-cancer) action by:

1. slowing cell proliferation (division) by interfering with the cell cycle

2. inducing apoptosis (cell suicide)
3. inhibiting phase 1 enzymes (enzymes that convert harmless substances into carcinogens)
4. inducing phase 2 enzymes (enzymes that can attach carcinogens to molecules that facilitate speedy excretion) (Best, 2005).

Apart from polyphenols, Null, (2004), states that beta-carotene also helps to protect the body against many types of cancer by trapping and deactivating free radical and other oxygen metabolites that damage DNA causing cell mutations that lead to cancer. A study by Watson (1991), found that beta-carotene increases the number of natural killer cells and T-helper cells. This stimulation of the immune system suggests that beta carotene has cancer-prevention potential. Many studies conducted answer the question about β-carotene and cancer prevention: Is it the beta-carotene itself that provides this protection, or is it vitamin A which beta-carotene becomes in the body? According to Gaby and Singh (1991), 17 studies distinguishing between these two nutrients found that beta-carotene offered significant protection but that preformed vitamin A (from animal sources) was not associated with the incidence of cancer. This suggests that beta-carotene has specific protective effects at the cancer sites independent of its provitamin A activity.

Ipomoea batatas and *Moringa oleifera* have been proven to be good sources of phytochemicals including polyphenols and β-carotene. Islam *et al* (2006) state that sweetpotato leaves having about fifteen different anthocyanin compounds and about six different polyphenolic compounds are excellent sources of bioactive anthocyanin and polyphenolic constituents. Sufficient amounts of these polyphenols in the human

system slow cancer proliferation, induces apoptosis, inhibits harmful enzymes and induces beneficial enzymes.

Moringa oleifera apart from being rich in the above mentioned phytochemicals, also has some anticancer compounds that are unique to the plant including, (4-(4'-*O*-acetyl-α-L-rhamnopyranosyloxy) benzyl isothiocyanate, 4-(α-L-rhamnopyranosyloxy) benzyl isothiocyanate, niazimicin, pterygospermin, benzyl isothiocyanate, and 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate (Fahey, 2005). All these phytochemicals have an anticancer effect through different actions as stated above and this goes to prove that eating a higher intake of fruit and vegetables, getting a proper diet high in antioxidants and cutting out the cigarettes are the keys not only to avoiding cancer but to living longer generally.

2.3.3 FIGHT AGAINST CARDIOVASCULAR DISEASES

The definition of cardiovascular disease (CVD) given by Medicinenet.com (Definition of Cardiovascular disease, 2007) is; a general term used to classify numerous conditions affecting the heart, heart valves, blood, and vasculature of the body. Healthy food habits can help maintain normal blood pressure, desirable blood cholesterol levels and a healthy body weight. The optimal treatment for CVD according to the Creighton University Medical Centre (Cardiovascular Disease, 2007), is prevention and modification of risk factors since the progression of these diseases beyond prevention requires surgical intervention. Studies by Granato (2003) have indicated that sufficient intake of dietary antioxidant as found in sweetpotato and Moringa leaves may help in the prevention of cardiovascular diseases. The study shows that the goal of nutritional components and antioxidants is the elimination of

cellular waste products that build up in the bloodstream. The antioxidants, found in Moringa and sweetpotato leaves, quench free radicals by donating an electron and stabilizing the compound. Beta-carotene's most powerful role is to quench singlet oxygen, the reactive oxygen species that can generate free radicals by unloading its excess energy onto other molecules. Due to the fact that β-carotene is a large molecule consisting of a long string of 11 double bonded with single bonded in between, it can absorb the singlet oxygen's energy and spread it throughout the long chain of bonds. It then releases the energy as heat and returns to its usual state (Gaby and Singh, 1991). Also as reported by Hennekens (1992), it may offer some protection against the oxidative damage associated with low density lipoproteins (LDL), which transport cholesterol through the arteries and contribute to blocked vessels. Yet another way in which polyphenols help to prevent atherosclerosis is by boosting the activity of vitamin C, which in turn increases the levels of vitamin E. This synergy increases the overall resistance to oxidative stress (Very Berry- and Grape too, 2001).

Polyphenols, carotenoids and flavones, which are found in leaves and vegetables, have been studied for their abilities to prevent lipid peroxidation, inhibiting the development of atherosclerosis and lowering blood pressure. These antioxidants found in Moringa and sweetpotato leaves even help during digestion, inhibiting some of the oxidation of fats in gastric fluid (Granato, 2003). Beta-carotene as an antioxidant is a highly effective quencher of singlet oxygen (the unstable oxygen metabolites with altered energy states) and a direct scavenger of free radicals. In addition, beta-carotene survives the process of absorbing singlet oxygen intact. Therefore, as reported by Null (2004), a single molecule of beta-carotene can arrest

up to 1,000 molecules of singlet oxygen. Some of the best-known sources of these antioxidants are sweetpotato and Moringa leaves.

2.3.4 *FIGHTING AGE-RELATED MACULAR DEGENERATION* (AMD)

Age-related macular degeneration is a disease associated with aging that gradually destroys sharp, central vision needed for seeing objects clearly and for common daily tasks such as reading and driving. It progressively destroys the macula (Fig 2.4), the central portion of the retina, impairing central vision (National Eye Institute, 2006).

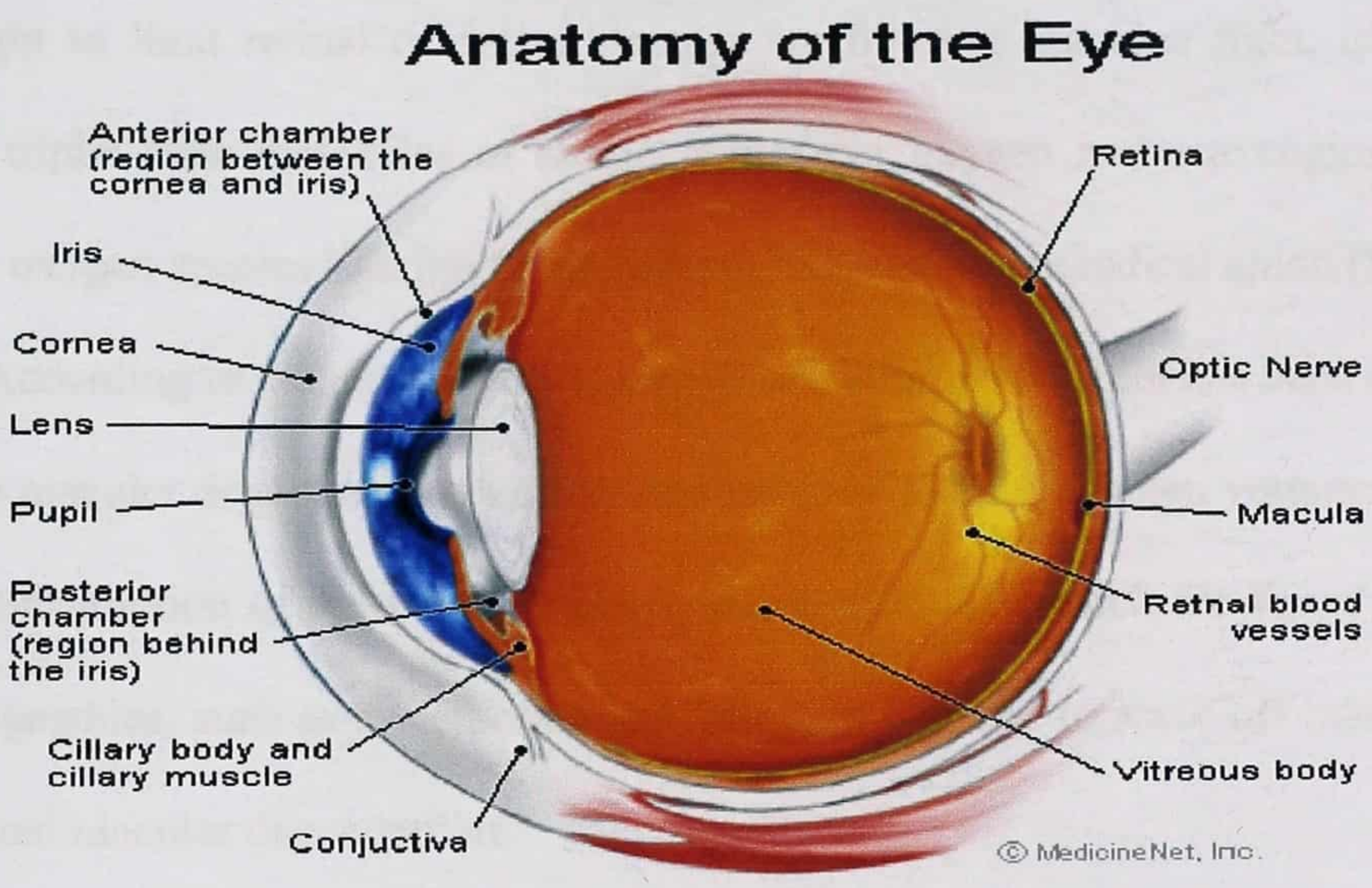


Fig. 2.4 Human Eye (MedicineNet.com, 2006)

Several authors (Henahan, 2001; National Eye Institute, 2006; Haddrill, 2006; The University of Michigan Kellogg Eye Centre, 2006; Thehealthierlife.co.uk, 2006) report that age-related macular degeneration occurs in two forms; 'wet' and 'dry'. Wet AMD occurs when abnormal blood vessels behind the retina start to grow under the macula and since these blood vessels are fragile, they leak blood and fluid which raises the macula from its normal place at the back of the eye causing damage to the

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macula. Dry AMD occurs when the light-sensitive cells in the macula slowly break down, gradually blurring central vision in the affected eye. As dry AMD gets worse, you may see a blurred spot in the centre of your vision. Over time, as less of the macula functions, central vision is gradually lost in the affected eye. The retina is particularly susceptible to oxidation as its need for oxygen is large. Carotenoids, having antioxidant properties, reduce the risk of retinal cells being oxidized and damaged. Two of these carotenoids, lutein and zeaxanthin (together known as xanthophylls), are particularly important since they make up the macular pigment that is thought to limit retinal oxidative damage by filtering out blue light, quenching excited triplet state molecules or singlet molecular oxygen and scavenging further reactive oxygen species like lipid peroxides or the superoxide radical anion (Sahelian, 2007). According to the above author, supplementation with lutein has been shown to improve macular degeneration because in a study of healthy women younger than 75 years, consumption of diets rich in lutein and zeaxanthin, which are found in green leafy vegetables, such as sweetpotato and Moringa, seemed to stave off intermediate age-related macular degeneration.

The antioxidants (xanthophylls) that protect the retina by either delaying the progression of macular degeneration if one already has the eye condition (meaning that vision won't get worse as quickly) or by preventing the development of this serious eye disorder are listed as some of the phytochemicals found in *I. batatas* and *M. oleifera* (McLaren and Frigg, 2001; Best, 2005; Liu *et al*, 2006; Zija:Drink life in, 2007).

2.3.5 DEFENCE AGAINST AGING

In Mader (2006), aging is defined as a slow process during which the body undergoes changes that contribute to an increased risk of infirmity, disease, and death. According to him, there is great interest in gerontology, the study of aging, because in the next half-century, the number of people over the age of 75 years is expected to rise from the present 8 million to 14.5 million, and the number over age 80 years is expected to rise from 5 to 12 million (Mader, 2006). The present goal of gerontology is not necessarily to increase the life span, but to increase the health span, the number of years an individual enjoys the full function of body parts and processes.

Boelsma *et al*, (2001) describes the various effects aging has on the body. The skin becomes thinner and less elastic. There is less adipose tissue in the subcutaneous layer; therefore, older people are more likely to feel cold. Homeostatic adjustment to heat is also limited because there are fewer sweat glands for sweating to occur. The heart shrinks because of a reduction in cardiac muscle cell size. Growing inelasticity of lung tissue means that ventilation is reduced. Blood supply to the kidneys is also reduced. The kidneys become smaller and less efficient at filtering wastes. Salt and water balance are difficult to maintain, and the elderly dehydrate faster than young people. After age 50 years, the ability to hear tones at higher frequencies decreases gradually. The lens of the eye does not accommodate as well and also may develop a cataract. Glaucoma is more likely to develop because of a reduction in the size of the anterior cavity of the eye. Aging is accompanied by a decline in bone density. Osteoporosis, characterized by a loss of calcium and mineral from bone, according to Perricone (2002) and Mader (2006) is not uncommon.

Clearly, aging and age-associated diseases are promoted by free radicals and inflammation. The process can be dealt with by increasing dietary antioxidants, which can boost endogenous defences together with the body's antioxidants such as superoxide dismutases (SOD) and glutathione (Borek, 1997) in decreasing the incidence of age-associated disease in all organ systems.

As has been stated earlier, *Moringa oleifera* and *Ipomoea batatas* leaves are rich sources of dietary antioxidants such as: anthocyanins that have an anti-aging effect making those who consume it healthier (Anti-aging Supplement/Anthocyanins, 2007); vitamin E a defence against lipid oxidation, heart diseases (Borek 1997), cataracts (Robertson, 1991) and macular degeneration (Snodderly, 1995), protecting cells against the cancerous effects of x-rays, chemicals, air pollutants and ultraviolet light (Borek, 1997); carotenoids especially β-carotene which can disarm reactive oxygen molecules generated by sunlight and air pollution, prevent free radical damage to skin, eyes and lungs (Krinsky, 1989), prevent cancer risk in many sites as well as heart diseases; flavonoids such as isoflavones, resveratrol and catechins which inhibits the body's production of chemicals that increase inflammation and protects against cancer and heart diseases (Borek, 1997). Due to the fact that free radical damage accumulates with age, people should consume vegetables and fruits which contain antioxidants from an early age to achieve long-term benefits.

2.4 CRACKERS

2.4.1. *HISTORY OF CRACKERS*

A cracker is defined by the American Heritage Dictionary of English Language as a thin crisp wafer made from flour and water with or without leavening and shortening; unsweetened or semisweet. History is not clear when people first began to make

hardtack (crackers), but it's quite probable that its history began in prehistory. Prehistoric people boiled grains; they cooked grains and added vegetables and herbs to the mixture; and sometimes they ground it into a powder, mixed it with water, and dried it on a hot stone. Six thousand year-old unleavened biscuits have been found in Switzerland (Stradley, 2004).

The development of the cracker is attributed to Sylvester Graham, an American clergyman who in 1829 concocted the recipe for a cracker whose main ingredient was un-sifted, coarsely ground whole wheat flour. Touting his product as a health food, he produced and sold it locally. Over time, it became known the Graham cracker. According to the history given in Graham crackers, definition (2006), due to its popularity and innovation, other bakeries copied his recipe and eventually developed methods for its mass production. It was touted as a health food in the early 1800's, when Americans believed good eating meant as much meat and fowl as one could consume, the fatter the better (Barnhart and Metcalf, 1997). The different types of crackers depending on the ingredients used and nutritional value described in Crackers (2000) are: *Saltine*- a cracker sprinkled with salt before baking; *Soda cracker*- unsweetened cracker leavened slightly with soda and cream of tartar; *Oyster cracker*- a small dry usually round cracker; *Graham cracker*- semisweet whole-wheat cracker; *Wheat crackers*- crackers with more white than wheat flour; *Cream crackers*- crackers made with cream.

2.4.2 *SALIENT CHARACTERISTICS OF CRACKERS*

i. Ingredients:

The crackers shall consist of flour, water, leavening ingredients, and vegetable shortening or oil. The crackers may consist of salt, emulsifiers or other stabilizers, flavours, and other ingredients appropriate for the type of crackers

ii. Appearance and colour:

The crackers shall have a uniformly brown crust characteristic of the product. The crackers shall have typical volume, characteristic grain, and be evenly baked with colour highlights without evidence of scorching or burning. There shall be no foreign colour to the product. The delivered crackers shall not be crushed or damaged.

iii. Odor and flavor:

The crackers shall have a flavor and aroma characteristic of cream crackers. There shall be no foreign odors or flavors such as, but not limited to, scorched, stale, rancid, or mouldy.

iv. Texture:

The texture of the crackers shall have a characteristic texture for crackers. The crackers shall possess a firm, crisp crust.

v. Enrichment:

When enriched, the crackers shall have the enrichment ingredients evenly distributed in the finished product.

vi. Foreign material:

All ingredients shall be clean, sound, wholesome, and free from evidence of rodent or insect infestation.

vii. Fat content:

The fat content for crackers shall not be less than 5.0 percent or more than 15.0

percent.

viii. Moisture content:

The moisture content shall not exceed 6.0 percent (The U.S. Department of Agriculture, 1998).

2.4.3 *CURRENT CONDITIONS*

The U.S. Chamber of Commerce noted that cookie and cracker manufacturing was the fastest growing segment of the bakery industry in 1992. Shipments of all bakery products rose an average of 1.3 percent per year from the years 1987 to 1992. Sales of crackers for the same years, however, increased by rates of 2.3 percent (American Industries Information about Cookies and Crackers, 2005). Well into the late 1980s, bakery goods showed a consistent increase in sales, but consumption of sweet baked goods began to decline around 1992 (Howell, 2005).

It is reported by the American Industries Information about Cookies and Crackers (2005) that in the late 1990s crackers became the second largest segment of the dry grocery category in supermarkets, with carbonated beverages coming in first. Almost 98 percent of all households purchase cookies and crackers. Due to this market saturation, manufacturers of cookies and crackers have had to work harder at expanding their sources of sales. These sales points now include various countries in the world, Ghana inclusive.

2.5 GLUTEN INTOLERANCE

The definition of gluten given by Sheasby (2001) is a protein that occurs naturally in wheat and rye and is related to similar proteins in oats and barley. This means that

gluten is present in all foods that are made from these grains. Gluten intolerance also known as celiac disease is a genetic condition that makes people intolerant to gluten. This life-long condition affects about one in 200 people in the world (Gluten Intolerance and Celiac Disease, 2006). In fact in celiacs, this protein actually *attacks* the lining of the small intestine causing damage that flattens out the tiny villi. When a celiac eats food containing gluten, the intestine responds to the food as if it were a foreign body. The lining of the intestine becomes inflamed and this causes the villi to become flattened, reducing the surface area of the gut which is then no longer able to absorb nutrients efficiently. Over time, according to Sheasby (2001), weight loss and wasting can occur, leading to malnutrition. Severe symptoms reported by Corcoran, (2006), include chronic abdominal bloating and pain, diarrhea, constipation, weight loss and sometimes a blistery rash. Other symptoms include bone or joint pain, fatigue, depression, osteoporosis and anemia. Dermatitis herpetiformis (DH) is another form of gluten intolerance that affects the skin by forming lesions that are watery and *itchy* blisters. DH is only present when the patient has inherited the gene. In this case they always also have the intestinal symptoms as described above (Gluten Intolerance and Celiac Disease, 2006).

Up to date, no medication has been formulated against gluten intolerance and the best method of treatment is a gluten-free diet (Feighry, 1999; Sheasby, 2001; Corcoran, 2006). This means the avoidance of all foods made from grains containing gluten. Although avoidance of products containing gluten is straightforward, the complex manufacture of modern processed food means that the ongoing advice of a trained dietician is required. Individuals on any avoidance diet are at risk of developing deficiencies of micro-nutrients (e.g., thiamine, riboflavin, niacin, iron, selenium,

chromium, magnesium, folacin, phosphorus and molybdenum) (Steinman, 2007). It is therefore essential that patients consume lots of fruits and vegetables such as *Moringa oleifera* and *Ipomoea batatas*.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 SOURCE OF RAW MATERIALS

Leaves of seven (7) new varieties of *I. batatas* (Sauti, Ogyefo, Apomuden, Otoo, Hi Starch, Okumkom, and Santom Pona) were harvested from the Crops Research Institute (CRI) at Fumesua, Kumasi. One specie from the Moringaceae family common in Ghana *M. oleifera* leaves used for this project was obtained from the Horticulture Department of the Faculty of Agriculture, KNUST, Kumasi. Both species of leaves were grown in the wet semi-equatorial climate of Ghana with temperatures between 26 - 30°C and relative humidity between 70 - 80%. Soil in the area is of the forest ochrosol type which is less leaching and contains greater nutrients (Dickson and Benneh, 1980).

3.2 SAMPLE HARVESTING

The *I. batatas* leaves were harvested during the rainy season at the phase of rapid growth of vines and hence large increase in leaf area. Leaves for *M.* oleifera were harvested during the same period as the *I. batatas* leaves, when new branches and pinnae were being formed. The *I. batatas* tops obtained were harvested after 15 cm apical tip of the vine, including the stem, petioles and tender leaves of the plant. The *M.* oleifera leaves were also harvested at 15 cm from the tip of the pinnae. The young tips were harvested because they are tender and not as tough as the older leaves (Woolfe, 1992; Fuglie, 2001).

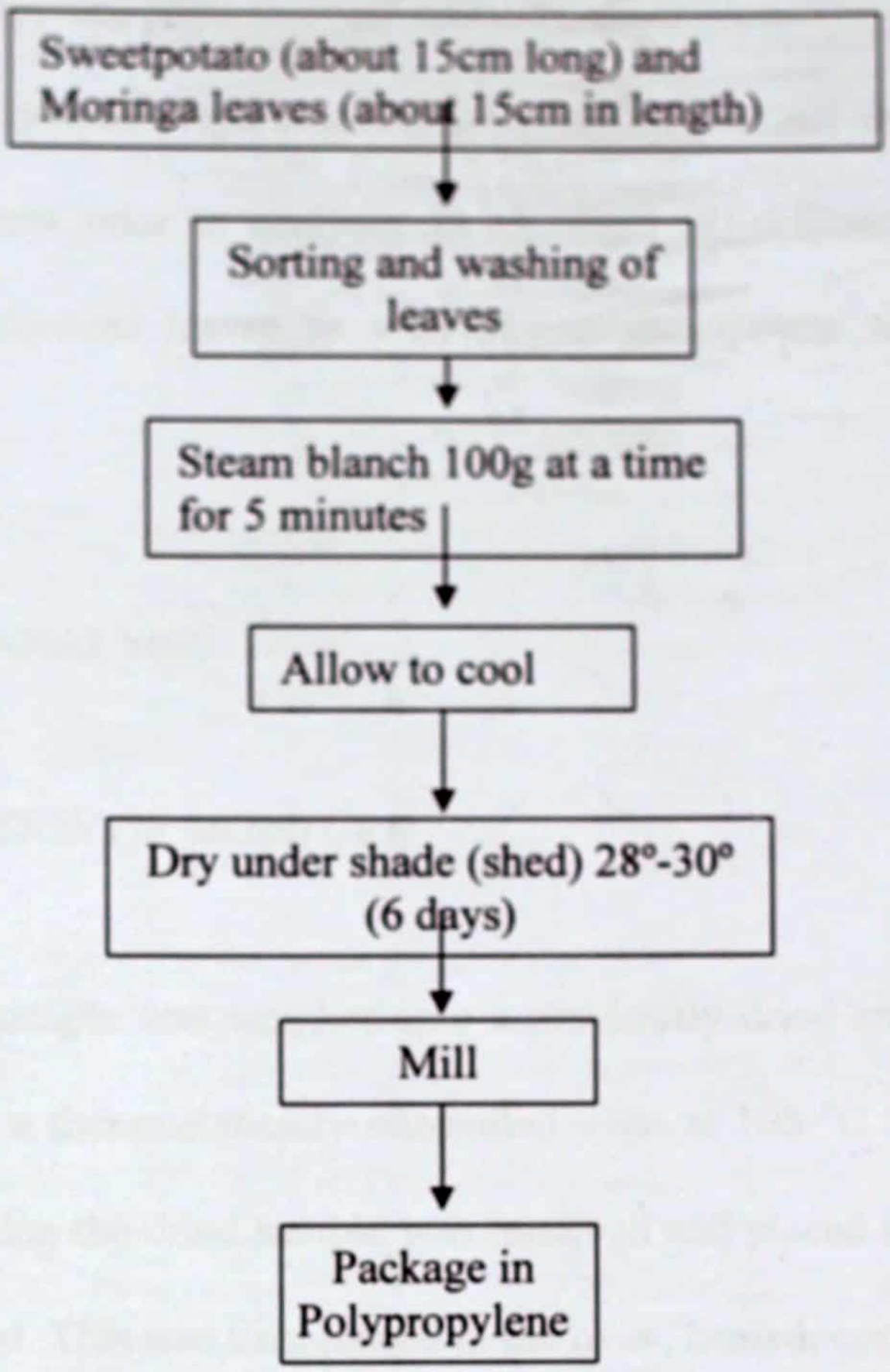

Fig 3.1 Preparation of Leaves

3.3 PREPARATION OF THE LEAVES

The *Ipomoea batatas* tops (about 15 cm in length from the tip of the plant) and *Moringa* leaflets obtained after harvesting were sorted to eliminate damaged ones and washed. The leaves were steam blanched hundred grams (100 g) at a time for five minutes to ensure same treatment for all the tops (for both Moringa and Sweetpotato). This was done to inactivate the polyphenol oxidase enzyme which causes browning by oxidizing the phenolics present when the leaves are bruised as well as to preserve the nutritional value of the leaves. The samples after the steam blanching were

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packaged into polypropylene films to avoid moisture absorption. The packaged leaves were placed in black polyethylene to avoid photo-oxidation. All the samples were stored in a deep freezer prior to analysis. In all, eight (8) different samples were obtained from the *Moringa* leaves as well as the sweetpotato tops. Pictures in Appendix A.

3.4 CHEMICAL ANALYSIS

3.4.1 DETERMINATION OF MOISTURE

Two grams (2 g) of sample was weighed into a previously dried and weighed glass crucible and dried in a thermostatically controlled oven at 105 ^{o}C for 6 hours. The glass crucible containing the dried sample was removed and placed in a desiccator to cool, and then weighed. This was then placed in the oven, heated, cooled and weighed again, repeating until a constant weight was obtained. The moisture content was then determined by difference and expressed as a percentage of the initial weight of the sample (AOAC, 1990). This was done in duplicates.

3.4.2 TOTAL ASH

Two grams (2 g) was weighed from each variety of the samples in duplicates into a previously washed, dried, ignited and weighed Gouch porcelain crucible and then the dish with its contents placed in a Muffle furnace (Gallenkamp, England) preheated to 600^{o}C for two hours (2 hrs). The crucibles and their contents were removed and cooled in a desiccator after which they were weighed. The ash content was then

sample.

3.4.3 DETERMINATION OF MINERAL MATTER

Mineral composition was determined by acid digestion of the ash after it had been weighed. 5 ml of 5 N HCl was added to the ash, allowed to cool, transferred into a 50 ml volumetric flask and made to the mark with distilled water. The mineral contents were then measured using the Atomic Absorption Spectrophotometric technique (AAS) (UNICAM model 929).

3.4.4 *CRUDE FAT DETERMINATION*

Two grams (2 g) of the moisture free sample was put in a paper thimble and plugged with cotton wool. The thimble was placed in a soxhlet extraction apparatus and extracted with petroleum ether (b.p 40-60 ^{o}C) and methanol mixed properly in the ratio 1:1, at low heat for 6 hours in a continuous extraction manner. The extract was collected in a flask and dried at 100 ^{o}C, cooled and weighed. The difference in weight between the empty flask and the flask and its dry contents was recorded as crude fat (Antia et al, 2006).

3.4.5 CRUDE FIBRE DETERMINATION

Two grams (2 g) of the de-fatted sample was transferred into a 750 ml Erlenmeyer flask and ½ g of asbestos was added. 200 ml of hot and boiling 1.25 % H_2SO_4 solution was added and heated to boil under reflux until the sample was thoroughly wetted for 30 minutes on a hot plate. The sample was then filtered through linen cloth in a funnel and washed thoroughly with boiling water until the washings were no longer acidic (did not change blue litmus paper red). The sample and asbestos were

its contents were refluxed for another 30 minutes. The sample with asbestos were again filtered and washed with boiling water until the washings were no longer alkaline (did not turn red litmus paper blue). They were then washed with 15 ml alcohol and the residue left was transferred into a Gouch porcelain crucible. The crucible and its contents was dried for 1hour at 105 °C in a drying oven and cooled in a desiccator, and weighed. The crucible and its content were then ignited in a muffle furnace for 30 minutes at 600 °C, cooled in a desiccator and reweighed. The loss of weight was reported as percentage crude fibre, (AOAC, 1990).

3.4.6 DETERMINATION OF CRUDE PROTEIN

The Kjeldahl method was used for the determination of the total nitrogen. Two grams (2 g) of sample was digested with 25 ml of concentrated sulphuric acid (H_2SO_4) in Kjeldahl digestion flask in the presence of a catalyst (Selenium tablet (½ tablets)) and anti bumping agents, in a fume chamber, until the solution was clear. The clear digested solution was transferred into a 100 ml volumetric flask and made to the mark with distilled water after cooling at room temperature. Distillation was carried out using the steam distillation apparatus.

25 ml of 2 % Boric acid was poured into a 250 ml conical flask and 2 drops of mixed indicator added. It was placed under the condenser outlet with the tip of the condenser completely immersed in the solution (Boric acid), 10 ml of the digested sample solution and about 20 ml of 40 % NaOH solution were transferred into the decomposition flask and well closed. Ammonia (NH_3) liberated during the distillation was collected by the Boric acid solution turning it bluish green. The distillation was

bluish green. The distillate was titrated with 0.1N Hydrochloric Acid (HCl) solution and the end point or titre, recorded. The titre values obtained were used to calculate the total Nitrogen. This was then converted into percentage crude protein by multiplying this percentage by an appropriate conversion factor (6.25). A blank was carried out using distilled water (AOAC, 1990).

3.4.7 TOTAL CARBOHYDRATE AND CALORIC VALUE

Total carbohydrate content of the samples was determined by subtracting the values of crude protein, crude fat, crude fibre and crude ash content from one hundred. The caloric value was determined by multiplying the protein, fat, and carbohydrate content by their Atwater factor (FAO, 2006a).

3.4.8 TOTAL PHENOLICS EXTRACTION

Total phenolics were extracted by a modification of the procedure described by Makkar *et al* (1993). Four hundred milligrams of plant samples (dried and finely ground) was weighed into centrifuge tubes. 20 ml of 70% aqueous acetone (with pH adjusted to 3 with acetic acid) was added to the samples and allowed to stand at room temperature for 20 min with intermittent gentle vortexing. The tubes were subjected to centrifugation for 10 min at approximately 3000 rpm at 4 °C. The supernatant (containing polyphenols) was collected and kept on ice.

3.4.9 SPECTROPHOTOMETRIC ASSAY ON FILTERATE

This assay is based on the principle that phenols or phenolic compounds react with phosphomolybdic acid in Folin-Ciocalteau reagent in alkaline medium, to produce a

blue coloured complex (molybdenum blue), which absorbs in the UV-Visible region. The total phenolic content was determined by a modification of the procedure described by Makkar *et al* (1993). 0.1 milliliters of aliquot of the polyphenol-containing extract was put into test tubes and the volume made up to 2 ml with distilled water. 1 ml of the Folin-Ciocalteau reagent (1N) and 5 ml of 20 % sodium carbonate solution was added. The tubes were vortexed and absorbance read at 725 nm after 40 minutes. The amount of total phenols was determined as tannic acid equivalent from a calibration curve prepared using standard tannic acid solution (0.1mg/ml). Total phenolic content was expressed on a dry matter basis.

3.4.10 BETA-CAROTENE DETERMINATION

0.05 g of the sample was weighed and ground smoothly with celite using mortar and pistil. 50 ml acetone was added while grinding to extract carotene. The extracts were filtered using the hand aspirator and the filtrate added to 20 ml of pet ether in a separating funnel. Water was gently added at the side of the funnel with each addition being allowed to separate with the removal of residual acetone, dried over anhydrous sodium sulphate. 100 ml of the concentration was evaporated to dryness with nitrogen gas and re-dissolved (reconstituted) in varying volumes of the mobile phase depending on anticipated concentration. The absorbance was then determined by spectrophotometer and HPLC (Detector-shimadzu SPD – 6AY; recorder-shimadzu C-R6A; Injector – Model 17125; Pump-shimadzu LC-^A; column-Zorbox ODS columns) (Rodriguez-Amaya and Kimura, 2004). Formulae for calculations shown in Appendix B.

3.5.1 *CRACKER PREPARATION WITH BUTTER.*

The oven was preheated to 218.3 °C. Four hundred and fifty grams (450 g) of flour, 28.35 g of sugar, 4.77 g of salt, and 2 g of each sample were sifted together into a large bowl. 56.25 g of butter was cut with 2 knives until it looked like cornmeal. 237 ml of milk was stirred in until the dough formed a stiff ball. On a lightly floured board, with a lightly floured rolling pin, the dough was rolled out until it was about 1/8 of an inch thick. With a 2-inch round cookie cutter dipped in flour, round crackers was cut out. These were placed on an ungreased cookie sheet and pricked on the top in several places with a fork. The top of each cracker was brushed with milk. The crackers were baked for 15-20 minutes, or until they were light gold, cooled on a rack and stored airtight at room temperature in a glass jar (Hodgman, 1995).

3.5.2 *CRACKER PREPARATION WITH CREAM*

The oven was preheated to 176.7°C. Two hundred and twenty five grams (225 g) flour, 4.77 g salt, 7.16 g sugar, 4.77 g baking powder and 2 g each of the samples were combined in a bowl. 158.79 ml of heavy cream was slowly added whiles stirring until the dough held together in a ball. The dough was rolled out to a thickness of about 1/8 inch and cut with a 3 inch cookie cutter. It was baked on one side for eight minutes, turned over and baked for a further 6-8 minutes. The crackers were then removed and placed on a rack to cool (Cream Crackers, 2005). Figure 3.2 shows the

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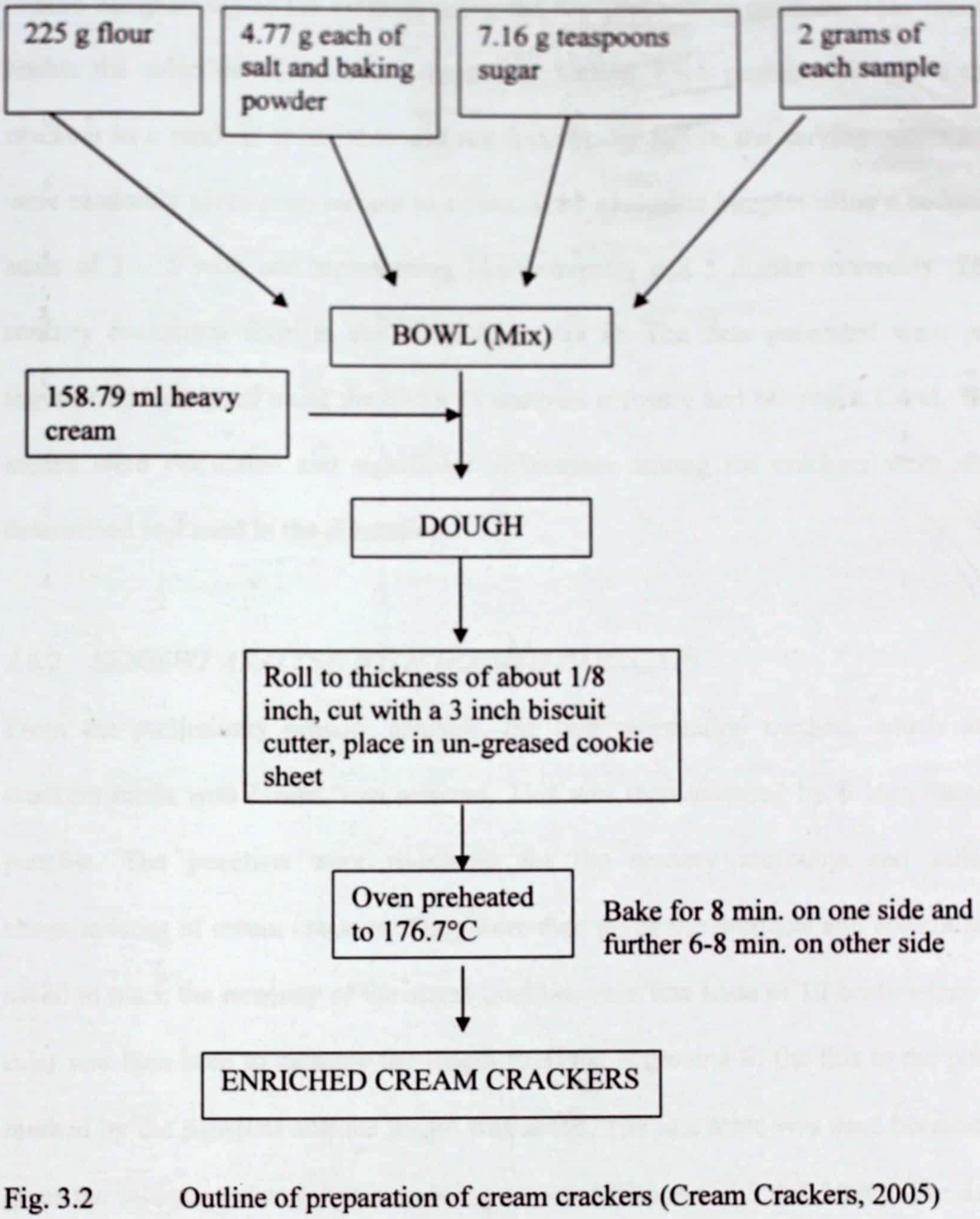

Fig. 3.2 Outline of preparation of cream crackers (Cream Crackers, 2005)

3.6 SENSORY ANALYSIS

3.6.1 SENSORY ANALYSIS WITH UNTRAINED PANELISTS

Sensory analysis was conducted on the cracker samples that were developed using cassava and sweetpotato flour and wheat flour as the control to find the degree of

product were used to assess the colour, aroma, mouth-feel, texture, taste, and the overall acceptability of the crackers using the two preparation methods. This was to enable the selection of the best preparation method. Each panelist was given the crackers in a random order; they did not specifically follow the serving orders but were randomly given each sample to assess. They evaluated samples using a hedonic scale of 1 – 5 with one representing like extremely and 5 dislike extremely. The sensory evaluation form is shown in Appendix D. The data generated were put together and analyzed using the SPSS 11 analysis software and Microsoft Excel. The means were calculated and significant differences among the crackers were also determined and used in the discussion.

3.6.2 SENSORY ANALYSIS WITH TRAINED PANELISTS

From the preliminary sensory analysis, the best preparation method, which was crackers made with cream, was selected. This was then assessed by fifteen trained panelist. The panelists were re-trained for the sensory attributes and salient characteristics of cream crackers. They were then given the products and control and asked to mark the intensity of the stated qualities on a line scale of 10 centimeters. A ruler was then used to measure the length from the beginning of the line to the point marked by the panelists and the length was noted. The line scale was used because it gives the intensity of each attribute being assessed (Stone and Sidel, 1996). The data generated were put together and analyzed using the SPSS 11 analysis software and Microsoft Excel. The means were calculated and significant differences among the crackers were also determined. The sensory evaluation form in shown in Appendix D.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 MOISTURE CONTENT

The moisture content of fresh samples showed Otoo as having the highest moisture content of 88.20 % with *Moringa oleifera* having the lowest moisture content of 76.53 % (Table 4.1) meaning that Otoo is more prone to deterioration. Statistical analysis of the data showed significant differences ($p<0.05$) between the samples except Okumkom and Ogyefo between which there was no significant difference ($p>0.05$). The significant differences are attributed to varietal differences. Values of moisture for both sweet potato leaves and *M. oleifera* leaves corroborated with standard references for sweetpotato: 82.21-87.48% (Woolfe, 1992; Antia et al., 2006; FAO, 2006[b]) and for *M. Oleifera*: 75.00% (Fuglie, 2001; Nutritional Value of Malunggay Pods/Leaves, 2006). The moisture content of the fresh samples was close to the literature value of 84.7 % and 84.1 % for leaves and tips respectively (FFTC, 2001).

It has long been recognized that there is a relationship between water content of food and its perishability (Fennema and Tannenbaum, 1996). Concentration and drying processes are conducted primarily for the purpose of decreasing the water content of a food, simultaneously increasing the concentration of solutes, and thereby decreasing perishability.

Table 4.1. Moisture content of Fresh, Blanched and Dried Leaf Samples*

Sample	Fresh Leaves (%)	Blanched Leaves (%)	Dried Leaves (%)
Apomuden	83.17±0.03^{a}	89.17±0.08^{a}	17.26±0.08^{a}
Hi Starch	80.16±0.08^{b}	87.73±0.06^{b}	21.21±0.10^{bc}
Moringa oleifera	76.53±0.02^{c}	76.43±0.06^{c}	18.48±0.06^{ad}
Ogyefo	85.15±0.06^{d}	89.51±0.07^{d}	17.07±0.04^{a}
Okumkom	85.15±0.06^{d}	89.55±0.03^{d}	19.14±0.08^{cd}
Otoo	88.20±0.09^{e}	87.65±0.04^{b}	15.43±0.03^{e}
Santom Pona	83.39±0.09^{f}	89.05±0.01^{a}	20.71±0.05^{bcd}
Sauti	84.33±0.07^{g}	88.38±0.08^{e}	16.90±0.09^{a}

* Mean values ± Standard Deviation Values
$^{a-h}$ Means in same column but with different superscripts differ significantly ($p<0.05$)

During the blanching process, a general trend was observed in which all the varieties except Otoo picked up moisture (Table 4.1). Of all the samples, Okumkom picked up the most water having a moisture content of 89.55 % followed by Ogyefo with a moisture content of 89.51 %. The Moringa leaves had the lowest moisture content of 76.43 %. No significant difference upon statistical analysis was observed between Apomuden and Santom Pona; Ogyefo and Okumkom; and Otoo and Hi Starch. There were however significant differences between Sauti and all the other samples as well as *Moringa oleifera* and all the other samples. The reason why the samples picked up water according to Taiz and Zeiger (2002) is because the water potential in the cell was lower than that in the environment. As water moves into the cell, the hydrostatic pressure, or turgor pressure of the cell increases. Consequently, the cell water potential increases, and the difference between the inside and outside water potentials is reduced eventually reaching equilibrium. Otoo lost water because as explained

above, the water pressure in the cell was higher than that in the environment so it lost water to the environment. This deviation from the trend observed is attributed to varietal difference in which the cell membrane of Otoo is able to keep in water better than the other varieties (Taiz and Zeiger, 2002). *Moringa oleifera* neither lost nor gained moisture during the blanching and this could be attributed to the water potential at equilibrium (Taiz and Zeiger, 2002).

Upon air drying under shade until constant weight, all the samples lost moisture (Table 4.1). Otoo had the lowest moisture content of 15.43 % followed by Sauti with a moisture content of 16.90 %. Hi Starch had the highest moisture content of 21.21 %. Statistical analysis of the data showed no significant differences between Apomuden, *Moringa oleifera*, Ogyefo and Sauti. Also there were no significant differences between Hi Starch, Okumkom and Santom Pona; *Moringa oleifera*, Okumkom and Santom Pona; Hi Starch and Santom Pona and this could be attributed to varietal differences. The low moisture content of the samples means that there is a concentration of solutes and decreased ability to perishability (Fennema and Tannenbaum, 1996). This makes the leaves ideal in usage since they are less likely to grow mouldy or help in the proliferation of bacteria. Low moisture content and water activity according to Fennema and Tannenbaum (1996) inhibit micro organisms. Therefore the dried leaves are more stable than the fresh leaves.

4.2 TOTAL ASH CONTENT

Of all the eight samples, Sauti had the highest ash content (11.60 %) followed by Hi Starch with a value of 11.37 %. It was noticed that all the samples had higher ash content than *Moringa oleifera* (7.13 %) (Table 4.2) which means that the sweetpotato

samples have higher total mineral content than the Moringa leaves. Of the sweetpotato leaf samples, Apomuden had the lowest ash content of 8.71 %. The results obtained for the crude ash contents of these indigenous vegetables are in agreement with those in literature (Woolfe, 1992; Antia *et al*, 2006) Statistical analysis of the data showed significant differences ($p<0.05$) among all the samples and this is attributed to difference in variety or specie (Haard, 1996; Woolfe, 1998).

Ash is composed of various minerals in different proportions in different plants and is used to express the total mineral content of plant tissue and is a useful index of mineral matter (dirt or sand) (Pomeranz and Meloan, 1987; Haard, 1996). A high ash content means that the mineral content of the food is also high. According to Haard (1996) the most abundant mineral elements in plants are potassium, calcium, magnesium, iron, phosphorus, sulphur, and nitrogen. This means that samples with high ash content (high total mineral content of the plant) are good in treating or preventing malnourishment.

Table 4.2 Proximate and energy composition of the leaf samples*

Sample	**Ash Content (%)**	**Crude Fat (%)**	**Crude Protein (%)**	**Crude Fibre (%)**	**Carbohydrate Content (%)**	**Caloric Value (cal/g**
Apomuden	8.71±0.03[a]	1.91±0.09[a]	23.39±0.05[a]	11.62±0.09[a]	54.38±0.03[a]	328.23±0.07
Hi Starch	11.37±0.06[b]	0.83±0.02[b]	21.89±0.00[b]	10.10±0.06[b]	55.81±0.01[b]	318.28±0.09
Moringa oleifera	7.13±0.03[c]	2.23±0.03[c]	27.51±0.00[c]	19.25±0.07[c]	43.88±0.01[c]	305.62±0.32
Ogyefo	9.75±0.03[d]	0.38±0.01[d]	22.69±0.00[d]	9.39±0.04[d]	57.79±0.00[d]	325.38±0.07
Okumkom	9.56±0.07[e]	1.46±0.03[e]	19.41±0.00[e]	12.14±0.00[e]	57.42±0.11[e]	320.49±0.11
Otoo	9.31±0.09[f]	1.61±0.02[f]	21.85±0.05[b]	10.66±0.18f	56.57±0.19[f]	328.21±1.19
Samtom Pona	9.90±0.09[g]	1.67±0.02[f]	25.39±0.00[f]	9.75±0.04g	53.29±0.03[g]	329.76±0.21
Sauti	11.60±0.03[h]	1.50±0.02[g]	16.78±0.00[g]	11.11±0.00[h]	59.01±0.05[h]	316.67±0.06

* Mean values ± Standard Deviation Values
[a-h] Means in same column but with different superscripts differ significantly ($p<0.05$).

4.3 MINERAL CONTENT

4.3.1 IRON CONTENT

Of all the samples, *Moringa oleifera* had the highest iron content (28.29 mg/100 g) (Table 4.3). Among the *Ipomoea batatas* samples, Hi Starch had the highest iron content of 23.02 mg/100 g followed by Okumkom (20.73 mg/100 g) with Otoo having the lowest iron content (9.62 mg/100 g) (Table 4.3). Statistical analysis of the iron content of the samples showed significant differences among the samples and this may be attributed to the different types of varieties. The iron content of all the leaf samples was higher than that of amaranth, cassava, cowpea, okra, pumpkin and taro leaves (FAO, 2006[b]).

The Ghana Demographic and Health Survey (GDHS, 2004) states that children, women of reproductive age and pregnant women are most vulnerable to micronutrient deficiency and anaemia. As a result they need to take in food with high iron content. Since iron deficiency affects about two billion people and recent estimates by Black (2003) shows that iron deficiency anemia is responsible for a fifth of early neonatal mortality and a tenth of maternal mortality, as well as reducing cognitive development and work performance, these leaves can be used to combat this problem. The high iron content of these leaves makes them a good source of iron for the invalid, anaemic, women, children and convalescent. They can also be used in the fight against iron deficiency.

Table 4.3 Iron and Calcium Composition of Leaf Samples*

Sample	Iron (mg/100g)	Calcium (mg/100g)
Apomuden	16.57±0.00[a]	1402.27±0.03[a]
Hi Starch	23.02±0.00[b]	1334.78±0.05[b]
Moringa oleifera	28.29±0.05[c]	2009.79±0.02[c]
Ogyefo	12.27±0.02[d]	1310.52±0.00[d]
Okumkom	20.73±0.04[e]	1326.19±0.06[e]
Otoo	9.62±0.07[f]	13.52.27±0.03[f]
Santom Pona	13.52±0.00[g]	1316.45±0.02[g]
Sauti	12.39±0.01[h]	1315.70±0.03[h]

* Mean values ± Standard Deviation Values
[a-h] Means in same column but with different superscripts differ significantly ($p<0.05$).

4.3.2 CALCIUM CONTENT

For calcium, Moringa had the highest calcium content of 2009.79 mg/100 g (Table 4.3). This was followed by Apomuden (1402.27 mg/100 g) and Otoo (1352.27 mg/100 g) with Ogyefo having the lowest value of 1310.52 mg/100 g. There were significant differences among all the samples at the 0.05 level of significance. The high level of calcium in *Moringa oleifera* means that it is a better source of calcium than the sweetpotato samples. However, in places where there is no Moringa tree, sweetpotato can equally be used to supplement the diet. According to FAO (2006[b]), the sweetpotato and Moringa leaf samples have higher calcium content than taro, pumpkin, amaranth, cassava and okra leaves.

It has long been known that calcium helps in good skeletal growth (Whitney and Hamilton, 1984) and it is very important especially in the diet of pregnant and lactating women, older women and children in the growing years. Whitney and Hamilton (1984) made it known that a developing calcium deficiency does not show

any symptoms like other diseases or deficiencies and becomes apparent only when a hip or pelvic bone suddenly shatters into fragments. Calcium plays other roles in the body apart from skeletal development (cell membrane integrity, regulation of ion transport, muscle action, transmission of nerve impulses, blood clotting, cofactor for several enzymes) and as a result, foods that are high in calcium are needed by the body. However it must be noted that approximately 85 % of kidney stones are composed predominantly of calcium compounds. The most common cause of calcium stone production is excess calcium in the urine (hypercalciuria). Excess calcium is normally removed from the blood by the kidneys and excreted in the urine. In hypercalciuria, excess calcium builds up in the kidneys and urine, where it combines with other waste products to form stones. Low levels of citrate, high levels of oxalate and uric acid, and inadequate urinary volume may also cause calcium stone formation (Kidney Stones; Overview, 2008).

Common sense has long held that consumption of too much calcium could promote the development of calcium kidney stones. However, current evidence suggests that the consumption of low-calcium diets is also associated with a higher overall risk for the development of kidney stones. This is perhaps related to the role of calcium in binding ingested oxalate in the gastrointestinal tract. As the amount of calcium intake decreases, the amount of oxalate available for absorption into the bloodstream increases; this oxalate is then excreted in greater amounts into the urine by the kidneys. In the urine, oxalate is a very strong promoter of calcium oxalate (CaO_x) precipitation, about 15 times stronger than calcium (Kidney Stone, 2008).

4.4 CRUDE FAT CONTENT

For fat analysis, Ogyefo had the lowest crude fat content of 0.38 % with Apomuden having a higher fat content of 1.91 % for the sweetpotato leaves. Moringa leaves had the highest fat content (2.23 %) among all the samples. Statistical analysis showed significant differences between Apomuden (1.91 %) and all other samples; Hi Starch (0.83 %) and all other samples; *Moringa oleifera* (2.23 %) and all samples and; Ogyefo (0.38 %) and all samples. These differences are attributed to differences in variety. There was however no significant difference between Otoo (1.61 %) and Santom Pona (1.67%) as well as Sauti (1.50 %) and Okumkom (1.46 %). Table 4.2 shows the crude fat contents.

A diet including *Moringa oleifera* should be more palatable than that with sweetpotato leaves because according to Lindsay (1996[a]) and Pomeranz and Meloan, (1987), dietary fats function in the increase of palatability of food by absorbing and retaining flavours. A diet providing 1 – 2 % of its caloric energy as fat is said to be sufficient to human beings, as excess fat consumption is implicated in certain cardiovascular disorders such as artherosclerosis, cancer and aging (Davidson *et al*, 1975; Kris-Etherton *et al*, 2002).

4.5 CRUDE FIBRE CONTENT

The crude fibre content of the sweetpotato samples was lower than that of Moringa leaves (19.25 %) (Table 4.2). Of the sweetpotato samples, Okumkom had the highest fibre value of 12.14 % followed by Apomuden (11.61 %) with Ogyefo having the lowest value (9.39 %). There were significant differences ($p<0.05$) amongst all the samples which may be attributed to varietal differences. Non-starchy vegetables are

the richest sources of dietary fibre (Agostoni *et al*., 1995) and are according to Saldanha (1995) employed in the treatment of diseases such as obesity, diabetes and gastrointestinal disorders. This makes *Moringa oleifera* a more favourable vegetable since high fibre content of foods help in digestion, prevention of constipation, and the prevention of colon cancer (IWES, 1971; Saldanha, 1995; UICC/WHO, 2005).

4.6 TOTAL PROTEIN CONTENT

Crude protein levels were between 16.78 % and 27.51 %. With the exception of Sauti (lowest value of 16.78 %) and Okumkom (19.41 %), all the leaf samples had protein levels above 20 % (Table 4.2). These levels are comparable with crude protein levels of lentil, cowpea and pigeon pea (Kay, 1979) which are highly recommended as substitute for animal protein. Comparatively Moringa had the highest protein value of 27.51 %. *Ipomoea batatas* leaves contain crude protein comparable with that of other leafy vegetables (cassava 24.88 %) (Akindahunsi and Salawu, 2005). Statistical analysis of the data obtained showed significant differences amongst all the samples except between Otoo and Hi Starch. According to Woolfe (1992), the major source of variation in leaf protein content is cultivar. It must be noted that the protein content for all the samples followed literature value (Price, 1985; Woolfe, 1992; Abbey *et al*, 2006) for sweetpotato and Moringa leaf proteins and is better when compared to other vegetables such as amaranth, taro leaves, pumpkin leaves and okra leaves (FAO, 2006[b]).

Lewis *et al* (2002) and Nelson and Cox (2000) stated that proteins consist of monomers of amino acids linked together to form polypeptide chains. Some amino acids listed as being present in Moringa leaves are, arginine, histidine, lysine,

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tryptophan, phenylalanine, methionine, threonine, leucine, isoleucine and valine (Nutritional value, 2006). Apart from their nutritional significance, proteins play a large part in the organoleptic properties of foods (Pomeranz and Meloan, 1987), this means that the leaves with high protein content will generally be more palatable than others with low protein content. From the protein values obtained, it can be deduced that these leaves can be used to supplement diets low in protein.

4.7 TOTAL CARBOHYDRATE CONTENT

Total carbohydrate content for the samples as shown in Table 4.2 indicate low levels ranging from 43.88 % (Moringa) to 59.01 % (Sauti). All the samples had total carbohydrate content below 60 %. Statistical analysis of the data showed significant differences ($p<0.05$) among all the samples. These differences are attributed to differences in cultivar. The low carbohydrate content of *Moringa oleifera* means that it is a more suitable vegetable for those who want to cut down on carbohydrate intake and for the obese who need less carbohydrate in their diet. This is because excess glucose, which is the subunit of carbohydrate (Nelson and Cox, 2000), in the body is converted to fat which in the end leads to obesity (Whitney and Hamilton, 1984). The leaves will also be good for diabetics who need less sugar or glucose in their diet.

4.8 CALORIC CONTENT

The caloric value obtained in Table 4.2 showed *Moringa oleifera* as having the lowest value (305.62 cal/g or 1296.09 kJ/g). Among the sweetpotato specie, Sauti had the lowest value (316.67 cal/g or 1343.96 kJ/g) whiles Santom Pona had the highest value (329.76 cal/g or 1399.41 kJ/g). The caloric value of these leaves make them a good source of energy for people and a good addition to the diet of the obese and

those who do not want to gain too much weight. Moringa having the lowest caloric content means that it is a better vegetable when compared to sweetpotato leaves in terms of lower calories for the obese and diabetic. There were significant differences between the samples except between Apomuden and Otoo which showed no significant difference ($p>0.05$).

4.9 TOTAL PHENOLIC CONTENT

Apomuden had the highest level of total phenolics (6.92 %) followed by Hi Starch (6.68 %) and Okumkom (4.55 %) as shown in Table 4.4. Of all the samples, *Moringa oleifera* had the lowest phenolic level of 1.51 %. Statistical analysis showed no significant difference between Otoo and Santom Pona. There were however significant differences between all the other samples at the 0.05 significance level attributed to varietal differences. Phenolic acids, a subset of polyphenols, protect the body's tissues against oxidative stress. Phenolics include anthocyanins, flavonoids, proanthocyanidins and tannins (Lindsay, 1996[b]). Islam *et al* (2006) stated that sufficient amounts of these phenolics in the human system slow cancer proliferation, induces apoptosis, inhibits harmful enzymes and induces beneficial enzymes.

Table 4.4 Total Phenolics and Beta-carotene content of Samples*

Sample	Phenolic content (%)	Beta-carotene content (mg/100g)
Apomuden	6.92 ± 0.01^{a}	9.89 ± 0.00^{a}
Hi Starch	6.68 ± 0.00^{b}	4.76 ± 0.00^{b}
Moringa oleifera	1.51 ± 0.00^{c}	23.43 ± 0.00^{c}
Ogyefo	2.51 ± 0.00^{d}	8.76 ± 0.01^{d}
Okumkom	4.55 ± 0.00^{e}	9.89 ± 0.00^{e}
Otoo	3.83 ± 0.02^{f}	10.02 ± 0.00^{f}
Santom Pona	3.81 ± 0.00^{f}	11.54 ± 0.01^{g}
Sauti	3.16 ± 0.00^{g}	5.14 ± 0.00^{h}

* Mean values ± Standard Deviation Values

[a-h] Means in same column but with different superscripts differ significantly ($p<0.05$)

Phenolics and carotenoids, which are found in leaves and vegetables, have been studied for their abilities to prevent lipid peroxidation, inhibiting the development of atherosclerosis and lowering blood pressure. These plant antioxidants even help during digestion, inhibiting some of the oxidation of fats in gastric fluid (Granato, 2003). Yet another way in which phenolics help to prevent atherosclerosis is by boosting the activity of vitamin C, which in turn increases the levels of vitamin E. This synergy increases the overall resistance to oxidative stress (Very Berry- and Grape too, 2001).

4.10 BETA-CAROTENE CONTENT

The beta-carotene levels of the leaves (Table 4.4) ranged from 4.76 mg/100g to 11.54 mg/100g for the sweetpotato leaves. Santom Pona had the highest β-carotene level of 11.54 mg/100g followed by Otoo with 10.02 mg/100g and Apomuden with 9.89

mg/100g. Hi Starch had the lowest level of 4.76 mg/100g. In all, *Moringa oleifera* had the highest β-carotene content of 23.43 mg/100g. Statistically all the leaf samples were significantly different at the 0.05 % significance level. The variation is attributed to varietal differences.

The level of beta-carotene in the samples exceed the recommended daily allowance for children ages 1-3 (1.5 mg/100g) (Fuglie, 2001). The high level of beta-carotene in the leaf samples make them good for human consumption since it works strongly against singlet oxygen, gives better cornea protection against UV light than lycopene and can boost the activity of Natural Killer (NK) immune cells (Best, 2005). Null (2004), states that beta-carotene also helps to protect the body against many types of cancer by trapping and deactivating free radical and other oxygen metabolites that damage DNA causing cell mutations that lead to cancer.

Upon analysis for the various nutritional components, Apomuden from the sweetpotato varieties was chosen. This is because it had higher total phenolics, calcium, and fibre. It also had appreciable levels of protein, iron and beta-carotene making it the overall best among the sweetpotato leaf samples. The Apomuden was added to the *Moringa oleifera* leaves in a one to one ratio and added to each cracker preparation.

4.11 SENSORY EVALUATION OF PRODUCTS BY UNTRAINED PANELISTS.

4.11.1 COLOUR ACCEPTABILITY

Amongst all the samples, the colour of cream crackers made with wheat was the one most liked with a mean score of 2.53 (Graph in Appendix E). Butter crackers made

with cassava (3.23) and cream crackers made with sweetpotato (3.00) and cassava flour (3.23) were neither liked nor disliked. Statistical analysis of the data showed significant differences between butter crackers made from cassava flour and butter crackers made from wheat and sweetpotato flour as well as cream crackers made from wheat flour; butter crackers made from wheat flour and cream crackers made from cassava flour; butter crackers made from sweetpotato flour and cream crackers made from cassava flour; cream crackers made from cassava flour and cream crackers made from wheat flour; cream crackers made from wheat flour and that made from sweetpotato flour.

4.11.2 AROMA

The aroma of cream crackers made from the three different types of flours was liked moderately with crackers made from cassava flour being the most liked with a mean score of 2.07 (see Appendix E). The aroma of the butter crackers were neither liked nor disliked with butter crackers made from wheat having the highest mean score of 3.40. There were significant differences ($p < 0.05$) between all the butter cracker samples and cream cracker samples but no significant differences between samples made with butter crackers as well as between samples made with cream crackers. This result could be as a result of the type of fat found in the heavy cream used in the cream cracker preparations not found in butter. According to Pomeranz and Meloan, (1987) and Lindsay (1996[a]), dietary fats function in the increase of palatability of food by absorbing and retaining aromas.

4.11.3 MOUTHFEEL

The mouthfeel of wheat and sweetpotato flour cream crackers were the most liked with mean scores of 2.40 and 2.70 respectfully. All the other samples were neither liked nor disliked. Cassava and sweetpotato flour butter crackers had the highest scores of 3.10 each meaning that they were the least preferred. Statistical analysis at the 0.05 significance level showed significant differences between butter crackers made from cassava flour and wheat and sweetpotato flour cream crackers. There were also significant differences between cream crackers made from wheat flour and all samples except cream crackers made from sweetpotato flour as well as between cream crackers made from cassava flour and cream crackers made from wheat and sweetpotato flour. Cream crackers made from wheat flour were the most preferred and this could be as a result of gluten in the wheat flour on which the leavening agent, baking powder, worked. This made the crackers more flaky and crisp (Leavening, 1996) and therefore more easy to chew.

4.11.4 TEXTURE

The mean scores for texture of the samples fell in a range from 2.57 (cream crackers made from wheat flour) to 3.20 (butter crackers made from wheat flour). There were significant differences ($p<0.05$) between butter crackers made from wheat flour and all the samples but no significant difference amongst all the other samples. This result was expected due to the fact that the baking powder acts on gluten found in wheat flour releasing carbon dioxide and therefore making the crackers more crisp and firm. The texture of butter crackers made from wheat flour was the least like in texture and this could also be attributed to the lack of baking powder in the preparation.

4.11.5 TASTE

The taste of cream crackers made from wheat flour was the most preferred having a mean score of 2.37. This means that the crackers were liked moderately. This was followed by sweetpotato flour cream crackers with a mean score of 2.63. There were significant differences ($p<0.05$) between all the cream cracker samples and all the butter cracker samples except that made from sweetpotato flour. These significant differences could be attributed to the heavy cream used in the preparation of the cream crackers because as stated earlier, dietary fat retain and release flavour (taste and aroma) of foods (Lindsay, 1996[8]).

4.11.6 OVERALL ACCEPTABILITY

For overall acceptability, all the cream cracker samples were liked moderately with mean scores of 2.03 (wheat flour), 2.07 (sweetpotato flour) and 2.40 (cassava flour). Butter crackers made from cassava, wheat and sweetpotato flours were neither liked nor disliked. Statistical analysis of the data showed significant differences between all the cream cracker samples and the butter cracker samples at the 5% significance level. There were however no significant differences between the butter cracker samples. This means that on the whole cream cracker samples were the most preferred (Appendix E).

4.12 RODUCT DEVELOPMENT AND CHEMICAL COMPOSITION

4.12.1 PRODUCT DEVELOPMENT

From preliminary sensory evaluation with untrained panellists, crackers made with cream, which was preferred was analysed for nutritional composition and also used for further sensory evaluation by trained panellists.

4.12.2 PROXIMATE COMPOSITION OF PRODUCTS

Proximate analysis of the product and control (Table 4.5), showed crackers made from wheat flour (control) as having the highest moisture content of 5.08 % and that made from cassava flour as having the lowest (3.14 %). Statistically, there were differences in the moisture content of all the product types. As stated earlier, the higher moisture content of the wheat flour means that it is more prone to deterioration and mould growth (Fennema and Tannenbaum, 1996). The moisture content did not exceed the 6.0 % level recommended by the U. S. Department of Agriculture (1998).

Ash content ranged from 2.75 % (wheat flour crackers) to 3.31 % (sweetpotato flour crackers). The ash content of the products were significantly different ($p<0.05$). The high ash content of the products is attributed to the incorporation of the Moringa and sweetpotato leaves. This is inferred because the ash content of the cassava and sweetpotato flours were lower than the ash content of their respective crackers. Also the ash content of wheat flour crackers was higher than that of commercial crackers on the market. Ash content is reflective of the total mineral content of the products (Pomeranz and Meloan, 1987; Haard, 1996) and this means that crackers made from the sweetpotato flour had higher total mineral content.

Cassava flour crackers had higher fibre content (1.92 %) than all the products. Wheat flour crackers had the lowest (0.55 %). Statistical analysis showed significant differences amongst the crackers. Since fibre content of foods help in digestion, prevention of constipation, and the prevention of colon cancer (IWES, 1971; Saldanha, 1995; UICC/WHO, 2005), cassava flour crackers is better than the others

in terms of fibre content and the prevention of these diseases. It was noticed that the fibre content of the sweetpotato and cassava flour crackers was higher than the fibre content of the flours. This is attributed to the incorporation of the Moringa and sweetpotato leaf samples.

Crude protein analysis showed crackers made from wheat flour as having the highest level (15.69 %) with cassava flour crackers having the lowest (3.29 %) amongst the developed products. This is expected because of the presence of gluten, a form of protein not found in cassava and sweetpotato flours (Sheasby, 2001). It can be said that the leaf samples added to the protein content of all the developed crackers since their protein content were higher than that of the flours and commercial crackers. This result shows that those who need more protein can add crackers made from wheat flour to their diets.

Crude fat content ranged from 10.31 % (cassava) to 16.47 % (wheat). The fat content of all the products except wheat flour crackers (16.47 %) fell in the range (5.00 %-15.00 %) given by the U.S. Department of Agriculture (1998). There were significant differences ($p<0.05$) among the products. Since fat contributes to total calories of a diet, those who do not want to gain too much weight can pick crackers with lower fat content (cassava flour crackers) for consumption. The increase in fat content of the products could be attributed to the heavy cream used in the preparation. However, it must be noted that according to Pomeranz and Meloan, (1987) and Lindsay (1996[a]), dietary fats function in the increase of palatability of food by absorbing and retaining flavours. Therefore, it can be said that crackers made with wheat flour was more palatable than the others.

Total carbohydrate content of the products was high ranging from 65.08 % to 81.28 %. Significant differences ($p<0.05$) were detected among the products. The high carbohydrate content of the products makes them a good source of energy for all people. However, the obese and those who do not want to gain weight should consider the caloric value of the products when consuming them.

Caloric value showed wheat flour as having the highest calorie per gram. This ranged from 431.02 cal/g for crackers made with cassava flour to 471.33 cal/g for wheat flour crackers (control). There were statistical differences among the products at the 0.05 % significance level. These caloric values means that the control is better for the obese followed by cassava flour crackers.

Table 4.5 Proximate composition of crackers and flour*

Sample	Moisture (%)	Ash (%)	Fibre (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Calorie (%)
Commercial crackers	3.21	1.41	2.80	9.86	13.51	67.6	431.0
Wheat flour crackers	5.08[a]	2.75[a]	0.55[a]	15.69[a]	16.47[a]	65.08[a]	471.33[a]
Sweetpotato flour	3.06	4.5	1.24	1.03	1.14	90.6	376.78
Sweetpotato flour crackers	4.87[b]	3.31[b]	1.79[b]	4.23[b]	13.29[b]	77.38[b]	446.09[b]
Cassava flour	3.53	1.68	1.75	1.56	0.70	85.32	353.82
Cassava flour crackers	3.14[c]	3.20[c]	1.92[c]	3.29[c]	10.31[c]	81.28[c]	431.02[c]

* Mean values ± Standard Deviation Values

[a-c] Means in same column but with different superscripts differ significantly ($p<0.05$)

4.13 SENSORY EVALUATION BY TRAINED PANELISTS.

4.13.1 COLOUR ACCEPTABILITY

The colour of the control, wheat flour crackers (mean score: 2.97), was picked as being the closest to the typical colour of crackers. This was reflected in the result given by the untrained panellists because they chose the colour of cream crackers made from wheat as the best. The colour of the cassava flour crackers was further away from the typical colour of crackers (mean score: 2.28). Statistical analysis showed no significant differences ($p > 0.05$) existed among the developed products. These scores were expected because of the addition of the Moringa and sweetpotato leaves, which give a faint greenish colour to the crackers due to the presence of chlorophyll. The results are shown in Fig 4.4.

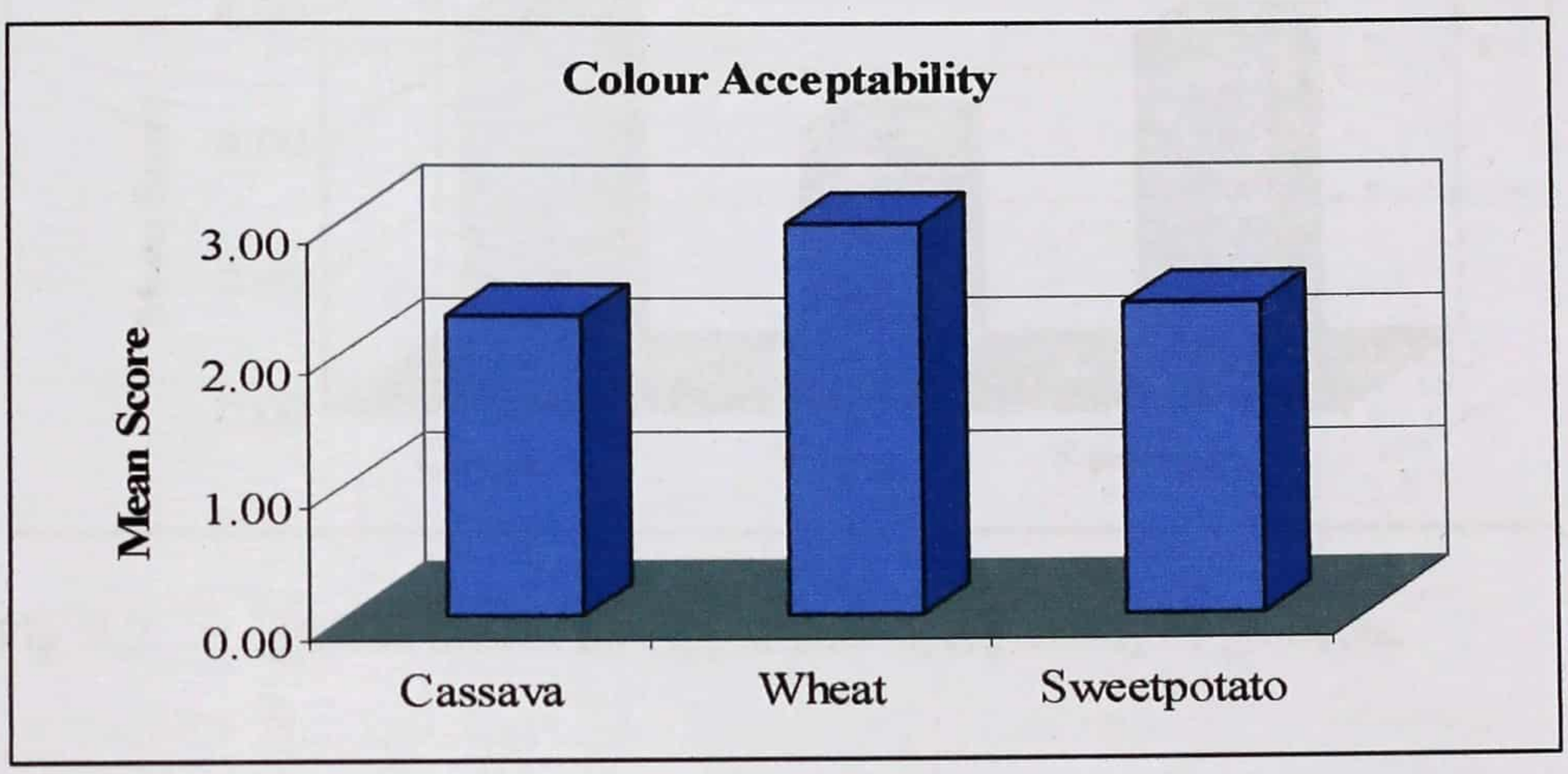

Fig 4.1 Mean Scores for Colour Acceptability of Products

4.13.2 APPEARANCE

Cream crackers made with cassava flour were less bumpy than all the other samples with a mean of 5.51 followed by that of sweetpotato flour with a mean score of 5.35. Of all the samples, the wheat flour crackers were the most bumpy with a mean score of 3.87 (Fig. 4.5). Statistical analysis of the samples showed no significant differences

($p>0.05$). The appearance of the products conformed with specifications, not being burnt or scorched (U. S. Department of Agriculture, 1998). Cream crackers are supposed to have a bumpy or rough surface due to the release of carbon dioxide from the leavening agent used (Leavening, 1996). The release of carbon dioxide expands the dough thereby increasing the volume of the cracker and also making the cracker flaky. The dough must be suitable for holding the expanded shape, before, during, and after cooking. Crackers made from cassava and sweetpotato flour were closer to being smooth because of the lack of gluten which help hold the volume even after the crackers cool and the leavening gases contract.

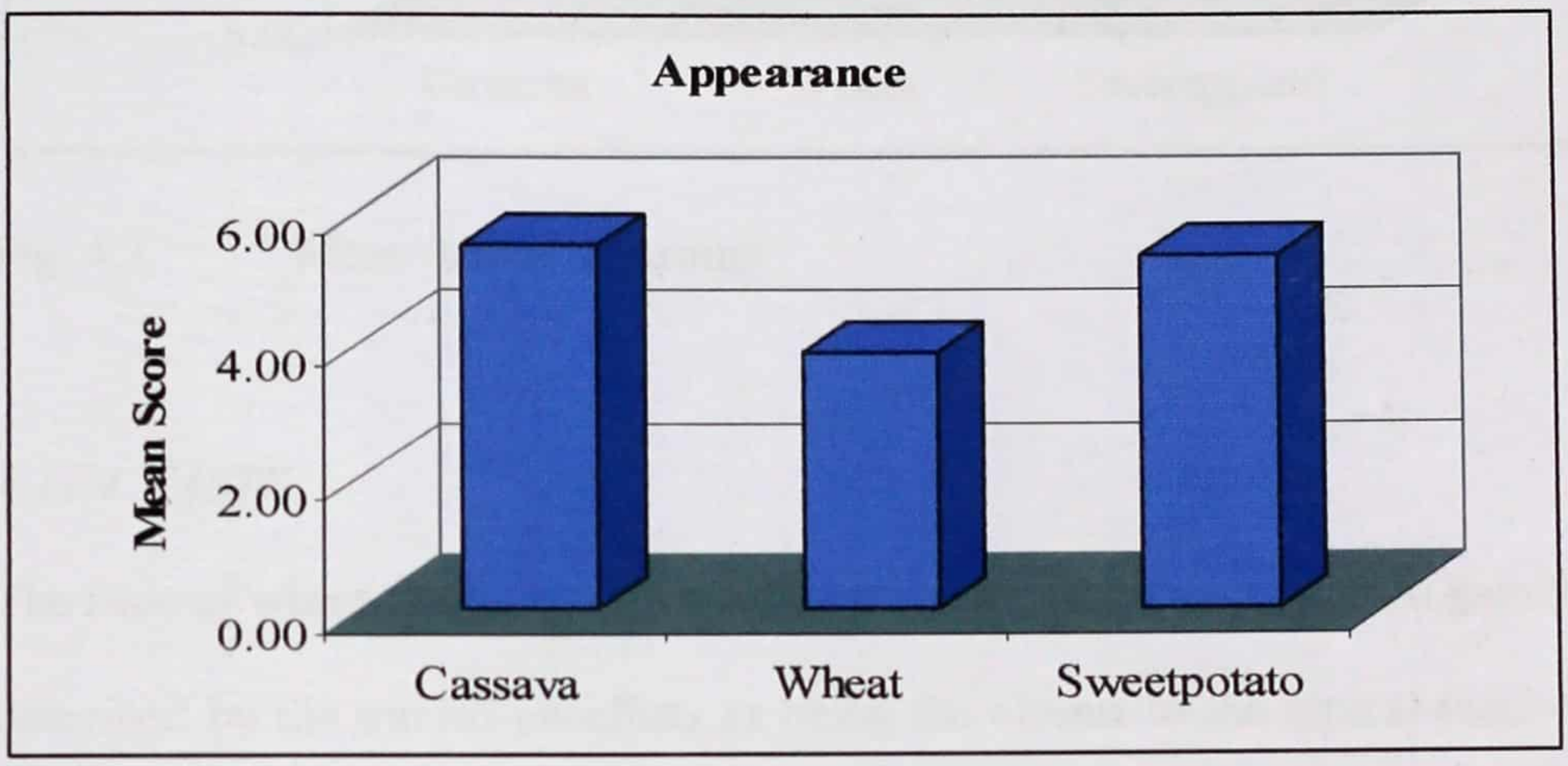

Fig. 4.2 Mean Scores for Appearance acceptability of products.

4.13.3 AROMA

The mean score for aroma of all the samples, shown in Fig. 4.6, passed the halfway mark and this means that the aroma of all the samples was closer to that of cream crackers. The aroma of the control was the closest to that of cream crackers with a mean score of 5.79, followed by sweetpotato flour crackers (5.48), and cassava flour crackers (5.33). Significant differences were not observed between the products. These results were expected because of the addition of heavy cream in the

preparation. The creamy aroma was enhanced also due to the fat in the cream. As stated earlier, dietary fats function in the increase of palatability of food by absorbing and retaining flavours (Lindsay,1996[a]; Pomeranz and Meloan, 1987). In terms of aroma, any of the products would be liked by consumers.

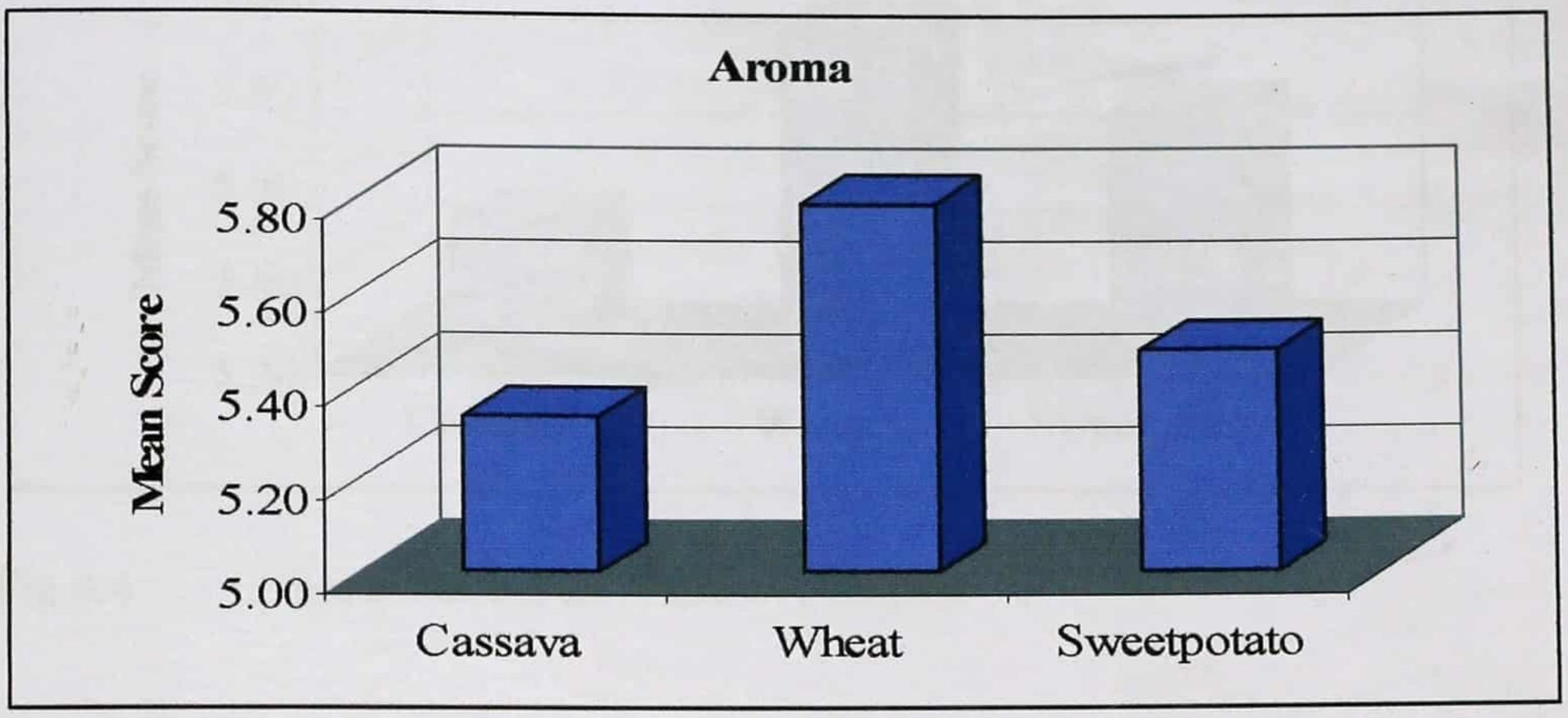

Fig. 4.3 Mean Scores of Aroma

4.13.4 TASTE

The taste of wheat flour crackers which was preferred by the untrained panellists was described by the trained panellists as being the closest to the typical taste of cream crackers (5.89). There was a slight bitter aftertaste tasted by the panellists and this is attributed to the presence of the leaf samples in the crackers. This is because some people claim to have a slight bitter aftertaste in their mouths after consumption of moringa leaves though this has not been proven scientifically. Crackers made from the wheat flour had a less bitter after-taste among the three products. The taste of crackers made from cassava flour was the least typical of cream crackers (5.48) and incidentally the one with the highest bitter after-taste (4.18). The means score for bitter after-taste did not exceed the halfway mark for all products. Statistical analysis

showed no significant differences ($p>0.05$) between the products for both taste and bitter aftertaste. These results are shown in Fig 4.4 and 4.5.

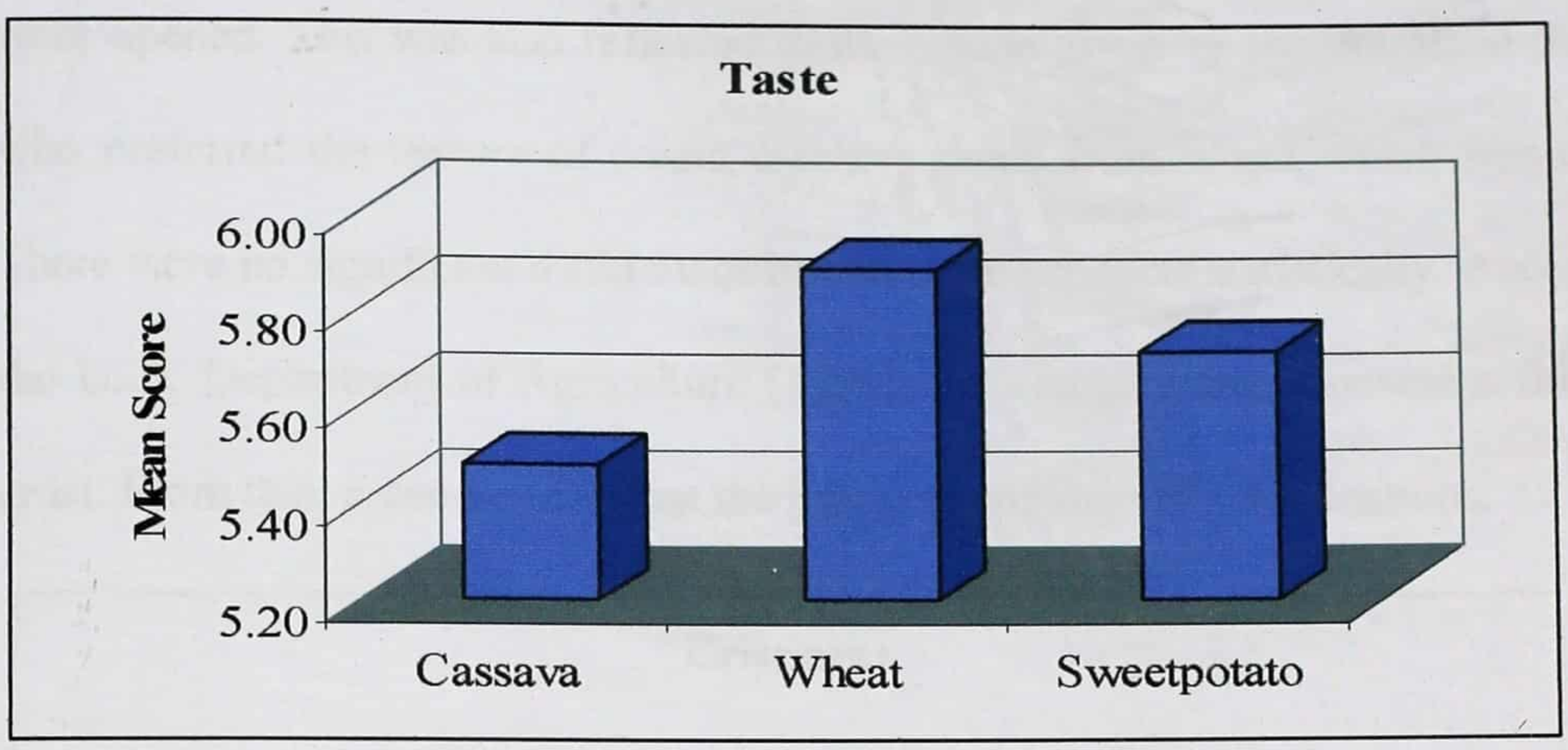

Fig 4.4 Mean Scores for Taste of Samples

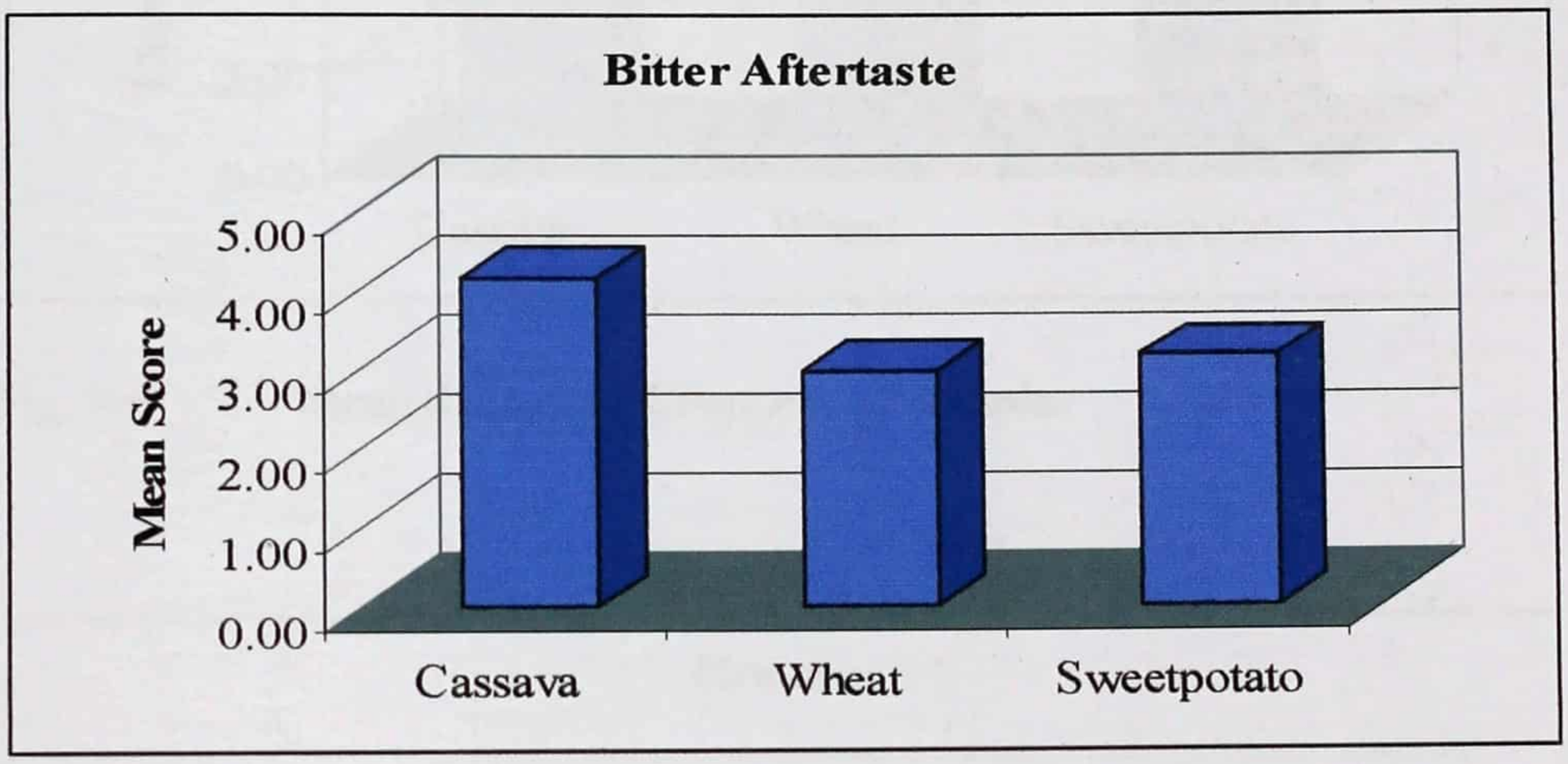

Fig. 4.5 Mean Scores for Bitter Aftertaste of Samples

4.13.5 TEXTURE

For texture (Fig. 4.6 and 4.7), all samples were crisp and firm. The control wheat flour crackers was crispiest (6.58), followed by cassava flour crackers (6.21) and sweetpotato flour crackers (5.36). When it came to firmness, the products were very firm. Crackers made from cassava flour were more firm (7.55) than all the others

(sweetpotato flour crackers: 7.21, wheat flour crackers: 6.42). The lower score of the control meant it was more prone to breakage which was observed when the packs were opened. This was also reflected in the results given by the untrained panellists who preferred the texture of cream crackers made from wheat which was crispier. There were no significant differences between the products statistically. According to the U. S. Department of Agriculture (1998), the crackers shall possess a firm, crisp crust. From this, it can be seen that the products conform to specifications.

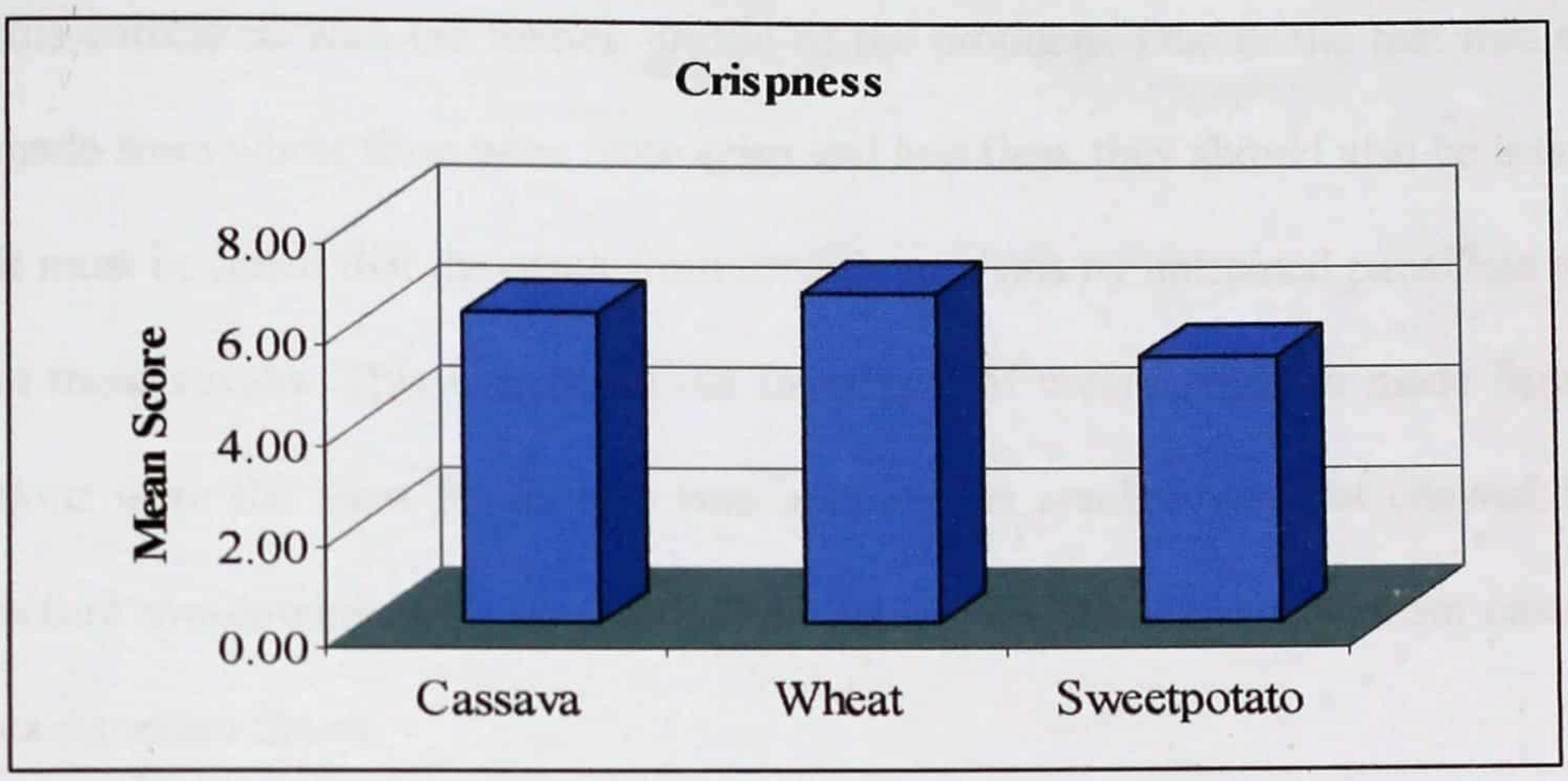

Fig. 4.6 Mean Scores for Crispness of Samples

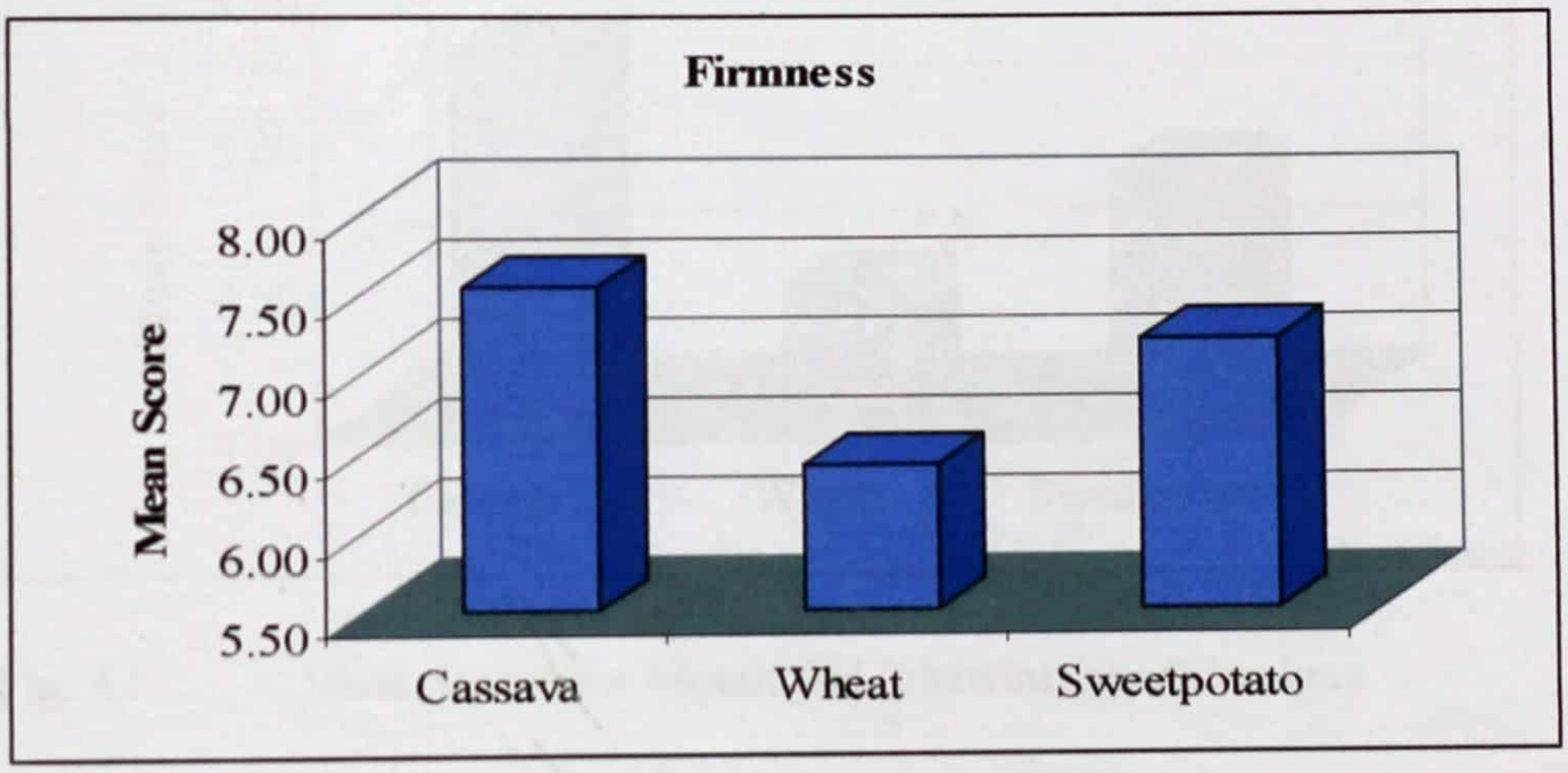

Fig. 4.7 Mean Scores for Firmness of Samples.

4.13.6 MOUTHFEEL

The chewiness of crackers made from cassava flour (5.24) was higher than all the samples as shown in Fig 4.8. The crackers made from wheat flour were the least chewy. There was however no significant differences among the products. The chewiness is described as how long one has to chew the crackers before swallowing it. Crackers should not be chewed for long because of their flaky nature due to the presence of a leavening agent. Crackers made from wheat flour were less chewy and this correlated with the texture profile of the products. Due to the fact that crackers made from wheat flour were more crisp and less firm, they should also be less chewy. It must be noted that the result from sensory analysis by untrained panellists reflected in these results. This is because the mouthfeel of cream crackers made from wheat flour were the most liked. This was because the cracker was not chewed for long before swallowing. The same principle applied to crackers made from cassava and sweetpotato flours.

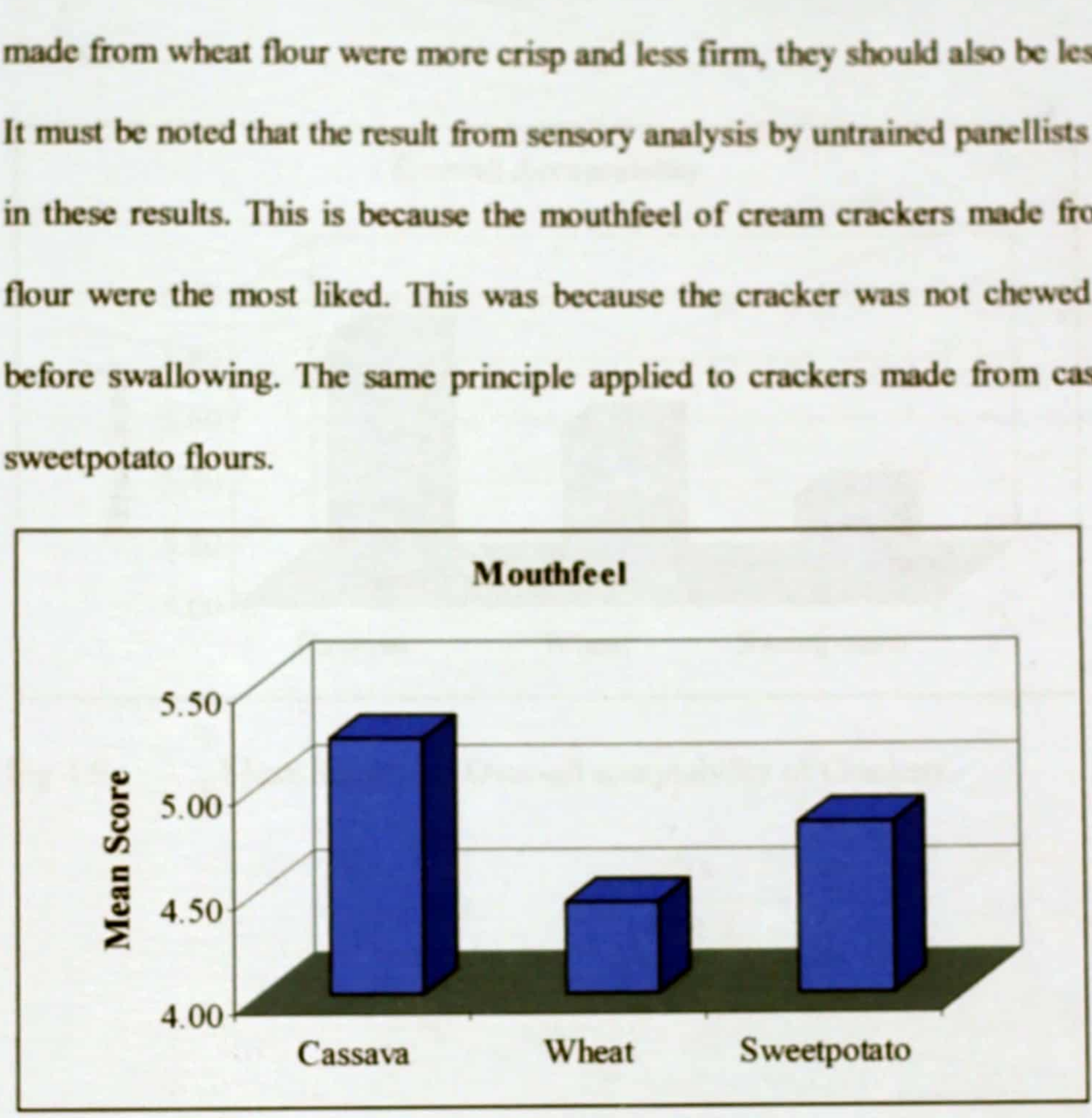

Fig. 4.8 Mean Scores for Mouth feel (chewiness) of Crackers

4.13.7 OVERALL ACCEPTABILITY

Of all the products, crackers made from cassava flour were the most preferred with a mean score of 5.81, whiles crackers made from sweetpotato flour had the least mean score (5.29). It must be noted that the mean score of all the samples passed the halfway mark (Fig. 4.9), which means that the samples were acceptable. There were no significant differences between the developed products. This means that those with gluten intolerance can opt for crackers made from cassava or sweetpotato flour and enriched with *Ipomoea batatas* and *Moringa oleifera* leaves without fear of celiac disease.

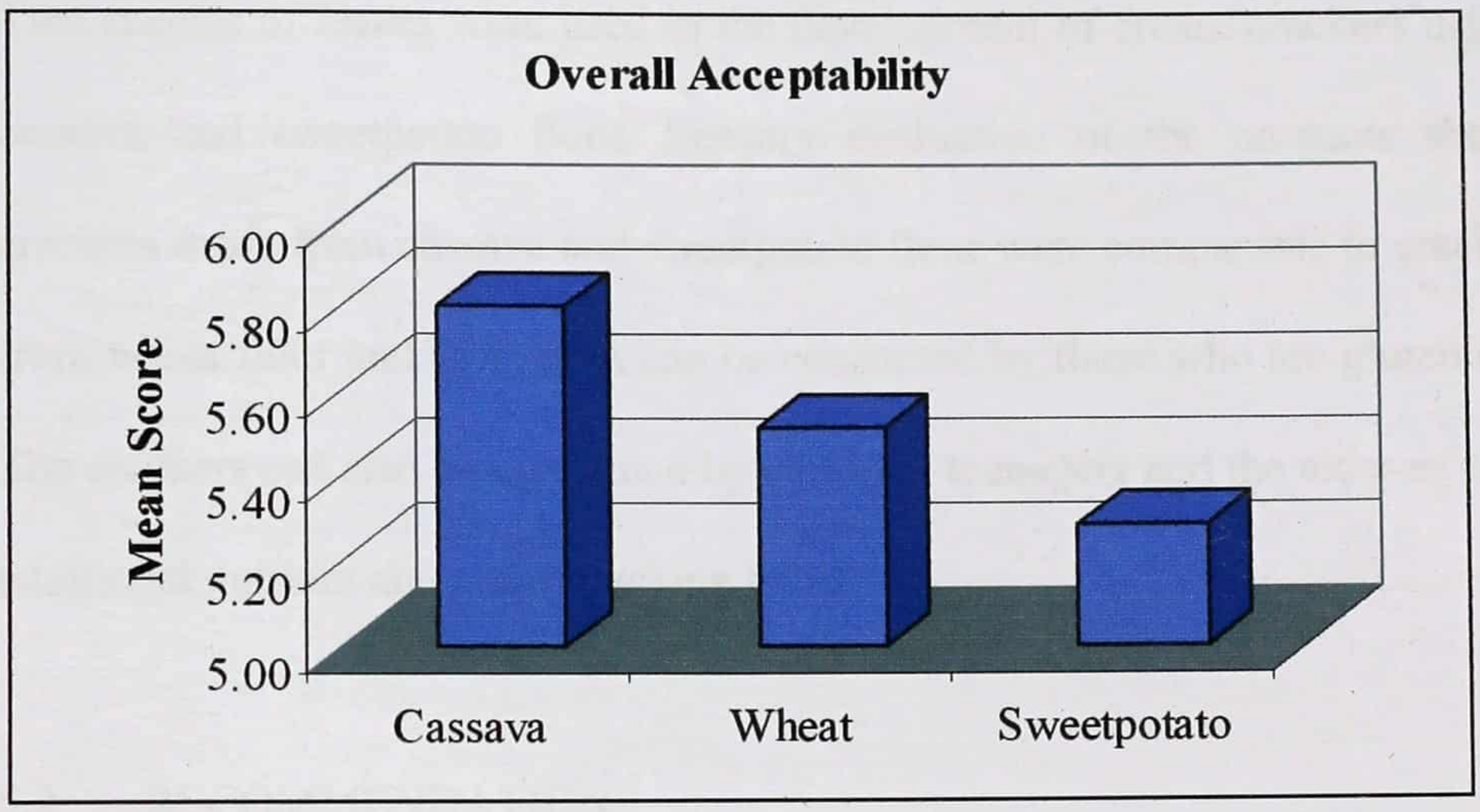

Fig 4.9 Mean Scores for Over-all acceptability of Crackers.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Moringa oleifera and *Ipomoea batatas* leaves are very nutritious when compared to vegetables such as cassava leaves, amaranth, mushrooms, taro, and pumpkin leaves. Relatively, Moringa leaves contain higher levels of calcium, iron and proteins making it a very rich source of dietary nutrients compared to the *I.batatas* leaves. However both leaves can contribute significantly to the nutrient requirements of humans.

Two species of leaves were used in the development of cream crackers using wheat, cassava and sweetpotato flour. Sensory evaluation of the products showed that crackers made from cassava and sweetpotato flour were comparable to crackers made from wheat flour and as a result can be consumed by those who are gluten intolerant. The crackers can also be consumed by children, teenagers and the elder as a source of additional nutrient and good snacking habit.

5.2 RECOMMENDATION

From the study conducted, the following recommendations are given:

- Public education about the high nutritional value of the leaves by organizing seminars, printing of flyers, and through the media.
- Animal studies to determine the bioavailability of the nutrients found in the leaves.
- Further research into the nutritional potential of other species of both Moringa and *Ipomoea batatas* leaves.
- Research into product development using sweetpotato and cassava flour.

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY KUMASI-GHANA

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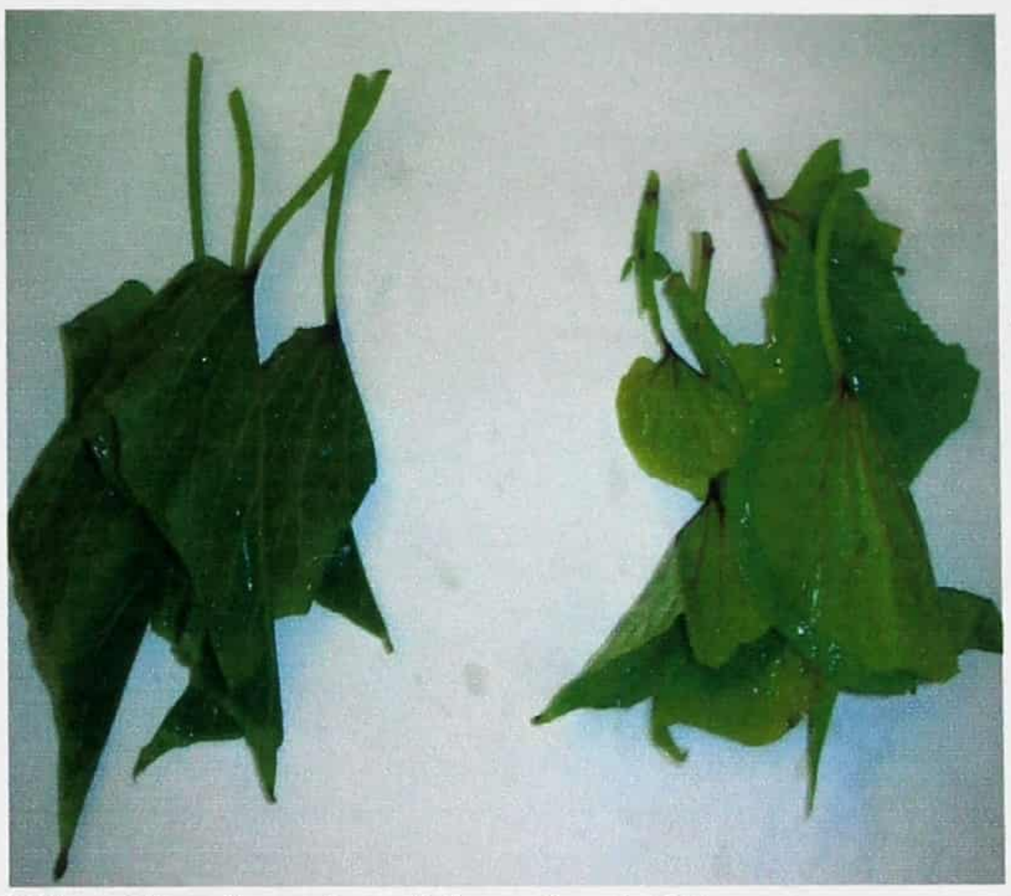
APPENDIX A

PLATE OF LEAVES

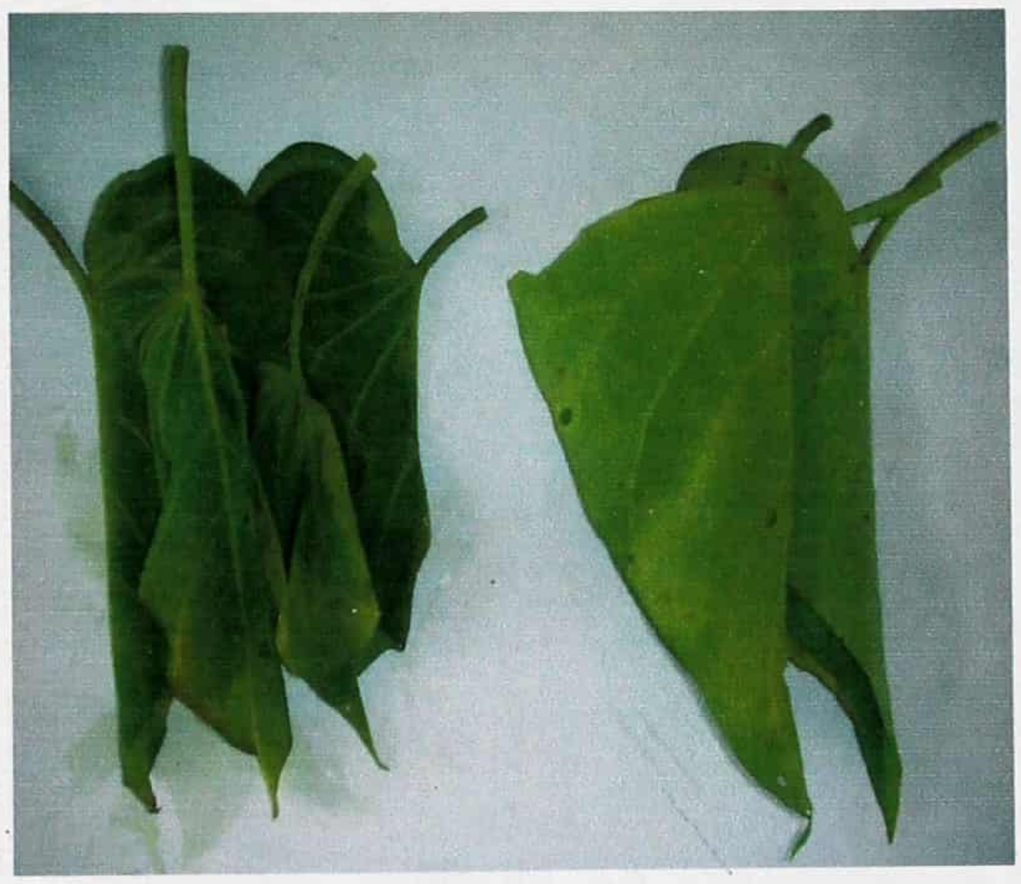
Blanched and unblanched Apomuden

Dried Apomuden



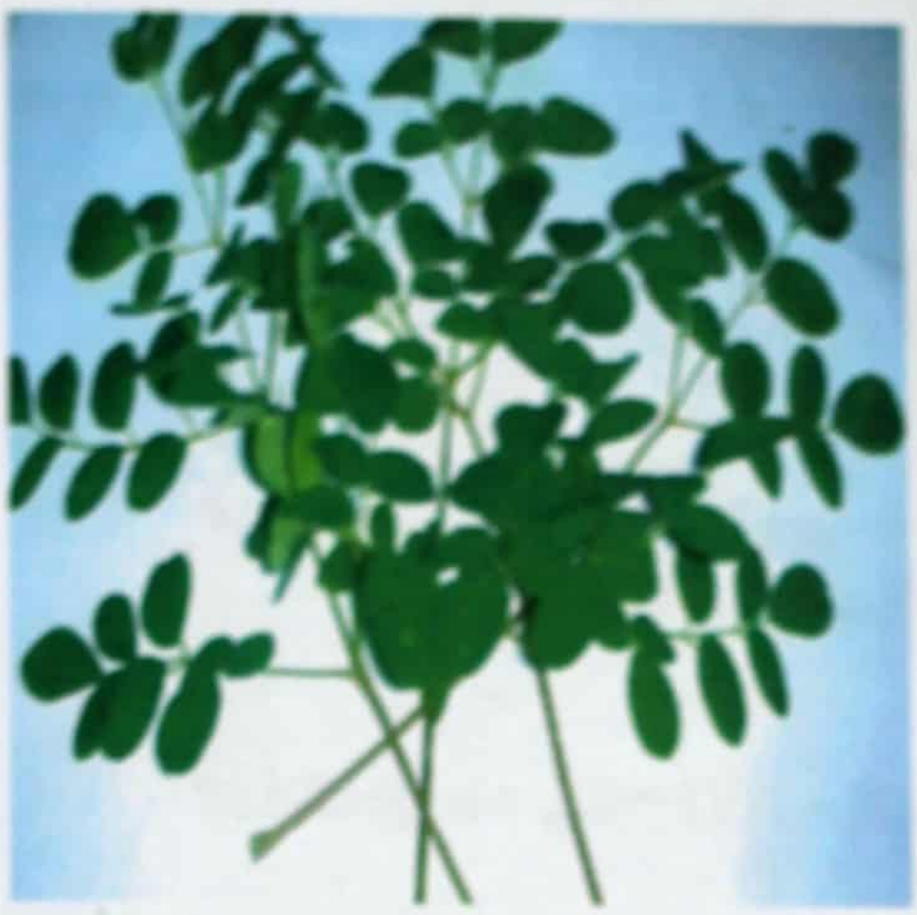
Blanched and unblanched Otoo

Dried Otoo



Blanched and unblanched Santom Pona

Dried Santom Pona



Fresh *Moringa oleifera*

Blanched *Moringa oleifera*

Dried *Moringa oleifera*

APPENDIX B

FORMULAE FOR CALCULATIONS.

1. $$\% \text{ Moisture content} = \frac{\text{loss in weight of sample}}{\text{Original weight of sample}} \times 100$$

2. $$\% \text{ Ash} = \frac{\text{weight of ash}}{\text{dry weight of sample}} \times 100$$

3. $$\% \text{ Nitrogen} = \frac{100 \times (VA - VB) \times NA \times 0.01401}{W \times 100}$$

$$\% \text{ Crude Protein} = \% \text{ total nitrogen} \times 6.25$$

4. $$\% \text{ Crude Fat} = \frac{\text{Weight of fat}}{\text{dry weight of sample}} \times 100$$

5. $$\% \text{ Crude Fibre} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

6. $$\beta\text{-carotene content } \mu g/\mu l = \frac{\text{Absorbance} \times 10{,}000}{2592 \times \text{sample weight}}$$

7. $$\text{Iron (mg/100g)} = \frac{50 \times \text{Concentration}}{\text{Sample weight} \times 10}$$

8. $$\text{Calcium (mg/100g)} = \frac{50 \times \text{Concentration} \times 100}{\text{Sample weight} \times 10}$$

9. $$\% \text{ Phenolics} = \frac{\text{Tannic acid} \times 20 \times 100}{0.1 \times \text{sample weight}}$$

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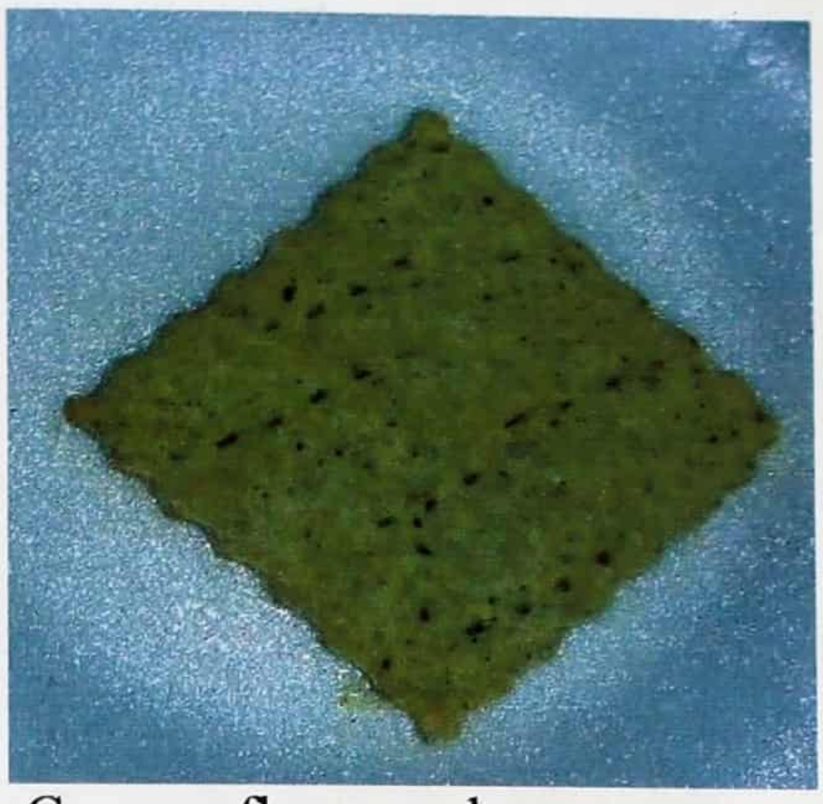
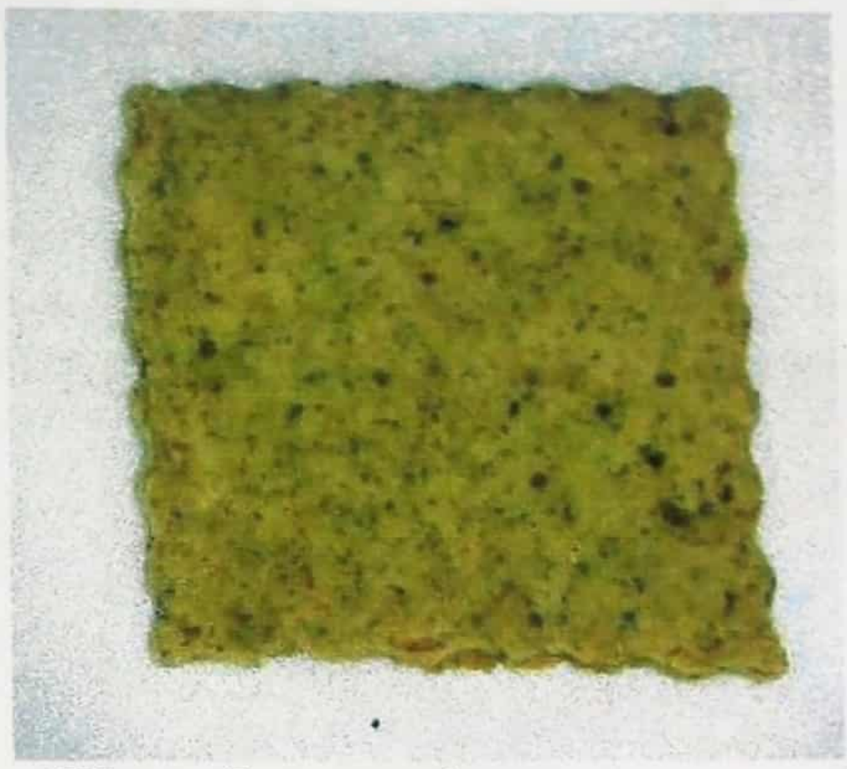
KUMASI-GHANA

APPENDIX C

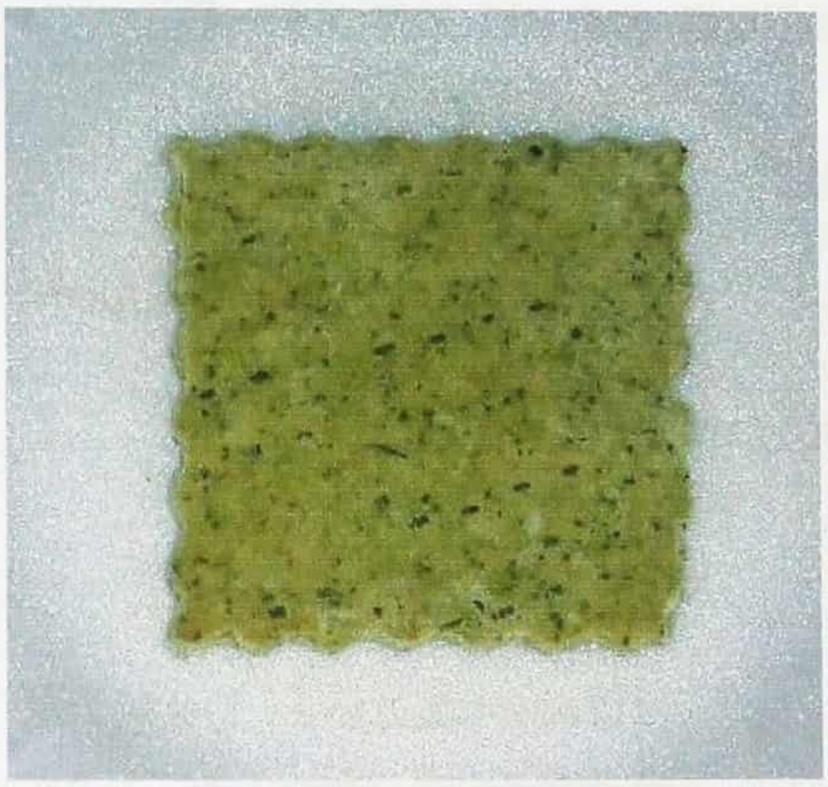
PLATE OF PRODUCTS



Cassava flour crackers



Wheat flour crackers



Sweetpotato flour crackers

Package of Crackers

Cream crackers

APPENDIX D

Kwame Nkrumah University of Science and Technology
Department of Biochemistry and Biotechnology
Sensory Evaluation Form

Name: _____ Sample Code: _____

Please tick the box which indicates your preference for the attribute of the sample.
Please rinse your mouth with the water provided after tasting each sample.

Colour:	1	Like extremely	[ ]
	2	Like moderately	[ ]
	3	Neither like nor dislike	[ ]
	4	Dislike moderately	[ ]
	5	Dislike extremely	[ ]
Aroma:	1	Like extremely	[ ]
	2	Like moderately	[ ]
	3	Neither like nor dislike	[ ]
	4	Dislike moderately	[ ]
	5	Dislike extremely	[ ]
Mouth-feel:	1	Like extremely	[ ]
	2	Like moderately	[ ]
	3	Neither like nor dislike	[ ]
	4	Dislike moderately	[ ]
	5	Dislike extremely	[ ]
Texture:	1	Like extremely	[ ]
	2	Like moderately	[ ]
	3	Neither like nor dislike	[ ]
	4	Dislike moderately	[ ]
	5	Dislike extremely	[ ]
Taste:	1	Like extremely	[ ]
	2	Like moderately	[ ]
	3	Neither like nor dislike	[ ]
	4	Dislike moderately	[ ]
	5	Dislike extremely	[ ]
Over-all acceptability:	1	Like extremely	[ ]
	2	Like moderately	[ ]
	3	Neither like nor dislike	[ ]
	4	Dislike moderately	[ ]
	5	Dislike extremely	[ ]

Comments:

Kwame Nkrumah University of Science and Technology
Department of Biochemistry and Biotechnology
Sensory Evaluation Form

Name: _____

Sample Code: _____

Please mark the intensity of the attributes indicated below in reference to the sample.

Colour:

1 — 10

Not typical of crackers — Typical of crackers

Appearance:

1 — 10

Bumpy — Smooth

Aroma:

1 — 10

Not typical of crackers — Typical of crackers

Taste:

1 — 10

Not typical of crackers — Typical of crackers

1 — 10

No bitter after-taste — Bitter after-taste

Texture:

1 — 10

Not crisp — Crisp

1 — 10

Not firm — Firm

Mouth-feel

1 — 10

Not chewy — Very chewy

Over-all acceptability

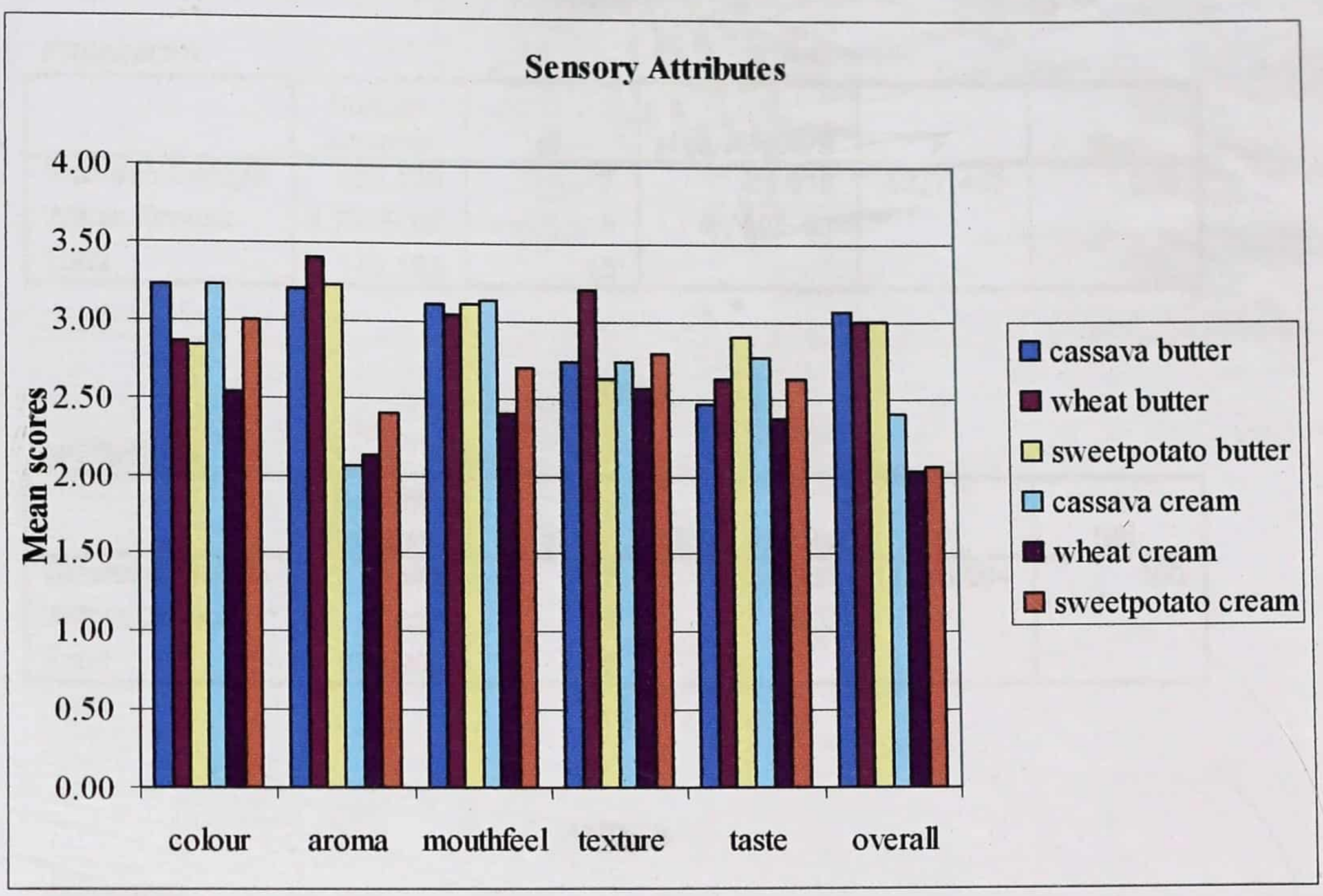
1 — 10

Dislike extremely — Like extremely

Comments:

+APPENDIX E

SENSORY ATTRIBUTE SCORES FOR UNTRAINED PANELLISTS



Sensory attributes scores for untrained panellist.

APPENDIX F

ANOVA Tables

ANOVA

FRESMOIS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	175.125	7	25.018	5277.493	.000
Within Groups	3.792E-02	8	4.740E-03		
Total	175.163	15			

ANOVA

MOISBLAN

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	272.178	7	38.883	11310.004	.000
Within Groups	.028	8	.003		
Total	272.206	15			

ANOVA

DRYMIOS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	76.385	7	10.912	20.280	.000
Within Groups	4.305	8	.538		
Total	80.689	15			

ANOVA

ASH

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	28.297	7	4.042	1165.986	.000
Within Groups	2.774E-02	8	3.467E-03		
Total	28.325	15			

ANOVA

FAT

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.842	7	.692	483.913	.000
Within Groups	1.143E-02	8	1.429E-03		
Total	4.853	15			

ANOVA

FIBRE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	140.565	7	20.081	2669.948	.000
Within Groups	6.017E-02	8	7.521E-03		
Total	140.625	15			

ANOVA

PROTEIN

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	154.355	7	22.051	36001.230	.000
Within Groups	4.900E-03	8	6.125E-04		
Total	154.360	15			

ANOVA

CARBO

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	318.936	7	45.562	6664.353	.000
Within Groups	.055	8	.007		
Total	318.991	15			

ANOVA

CALORIE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	921.145	7	131.592	501.171	.000
Within Groups	2.101	8	.263		
Total	923.245	15			

ANOVA

IRON

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	575.699	7	82.243	65911.568	.000
Within Groups	9.982E-03	8	1.248E-03		
Total	575.709	15			

ANOVA

CALCIUM

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	804791.8	7	114970.251	8.4E+07	.000
Within Groups	1.089E-02	8	1.361E-03		
Total	804791.8	15			

ANOVA

PHENOLIC

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	32.900	7	4.700	80687.005	.000
Within Groups	4.660E-04	8	5.825E-05		
Total	32.901	15			

ANOVA

BETA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	469.373	7	67.053	5364268	.000
Within Groups	.000	8	.000		
Total	469.374	15			

		Sum of Squares	df	Mean Square	F	Sig.
MOISPRDT	Between Groups	4.509	2	2.254	735.094	.000
	Within Groups	.009	3	.003		
	Total	4.518	5			
ASHPRDT	Between Groups	1.479	2	.739	1249.297	.000
	Within Groups	.002	3	.001		
	Total	1.480	5			
FIBREPRD	Between Groups	2.283	2	1.142	6567.172	.000
	Within Groups	.001	3	.000		
	Total	2.284	5			
CARBPRDT	Between Groups	31.127	2	15.564	9248.914	.000
	Within Groups	.005	3	.002		
	Total	31.132	5			
CALPRDT	Between Groups	365.048	2	182.524	1354.545	.000
	Within Groups	.404	3	.135		
	Total	365.452	5			
PROTPRDT	Between Groups	190.549	2	95.274	2684071	.000
	Within Groups	.000	3	.000		
	Total	190.549	5			
FATPRDT	Between Groups	38.019	2	19.009	11886.768	.000
	Within Groups	.005	3	.002		
	Total	38.023	5			

ANOVA TABLE FOR UNTRAINED PANELIST SENSORY ATTRIBUTES

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
COLOUR	Between Groups	10.717	5	2.143	4.345	.001
	Within Groups	85.833	174	.493		
	Total	96.550	179			
AROMA	Between Groups	54.828	5	10.966	19.489	.000
	Within Groups	97.900	174	.563		
	Total	152.728	179			
MOUTHFEE	Between Groups	13.244	5	2.649	5.401	.000
	Within Groups	85.333	174	.490		
	Total	98.578	179			
TEXTURE	Between Groups	7.444	5	1.489	3.024	.012
	Within Groups	85.667	174	.492		
	Total	93.111	179			
TASTE	Between Groups	5.628	5	1.126	3.040	.012
	Within Groups	64.433	174	.370		
	Total	70.061	179			
OVERALL	Between Groups	35.494	5	7.099	18.744	.000
	Within Groups	65.900	174	.379		
	Total	101.394	179			

ANOVA TABLE FOR TRAINED PANELISTS SENSORY ATTRIBUTES

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
COLOUR	Between Groups	4.161	2	2.081	.334	.718
	Within Groups	261.847	42	6.234		
	Total	266.008	44			
APPEARAN	Between Groups	24.320	2	12.160	1.715	.192
	Within Groups	297.716	42	7.088		
	Total	322.036	44			
AROMA	Between Groups	1.656	2	.828	.330	.721
	Within Groups	105.527	42	2.513		
	Total	107.183	44			
TASTE	Between Groups	1.254	2	.627	.480	.622
	Within Groups	54.865	42	1.306		
	Total	56.119	44			
BITTERAF	Between Groups	12.400	2	6.200	.717	.494
	Within Groups	362.972	42	8.642		
	Total	375.372	44			
CRISP	Between Groups	11.723	2	5.862	.758	.475
	Within Groups	324.669	42	7.730		
	Total	336.392	44			
FIRMNESS	Between Groups	9.922	2	4.961	1.902	.162
	Within Groups	109.524	42	2.608		
	Total	119.446	44			
CHEWYNES	Between Groups	4.721	2	2.361	.375	.690
	Within Groups	264.727	42	6.303		
	Total	269.448	44			
OVERALL	Between Groups	6.963	2	3.482	3.322	.046
	Within Groups	44.021	42	1.048		
	Total	50.984	44			

HPLC Readings for Beta-carotene

urseMate

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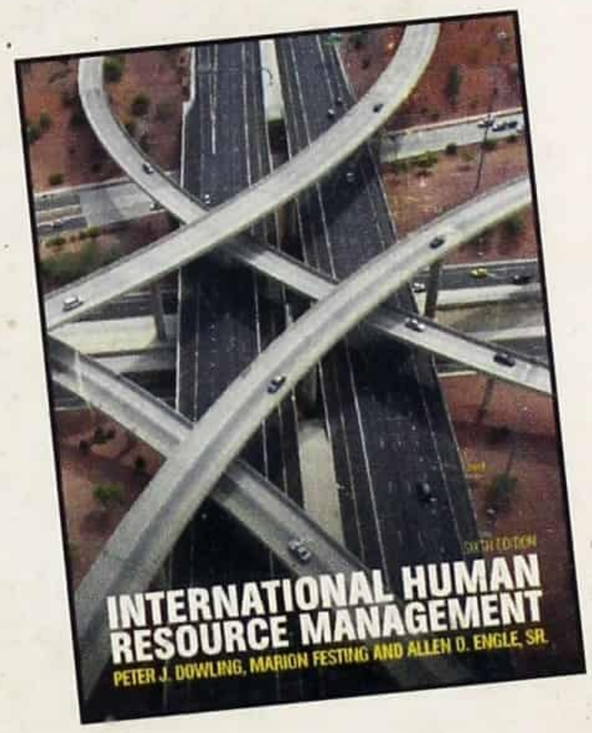
llen Engle



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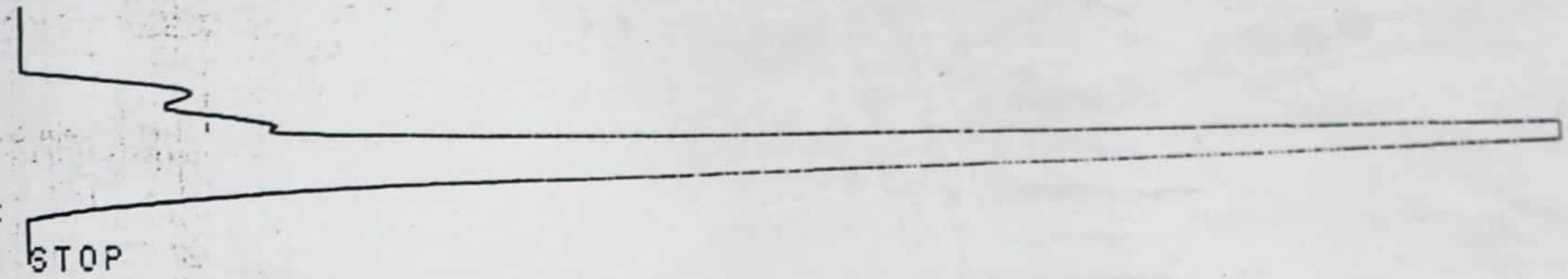
CALIB 3
START

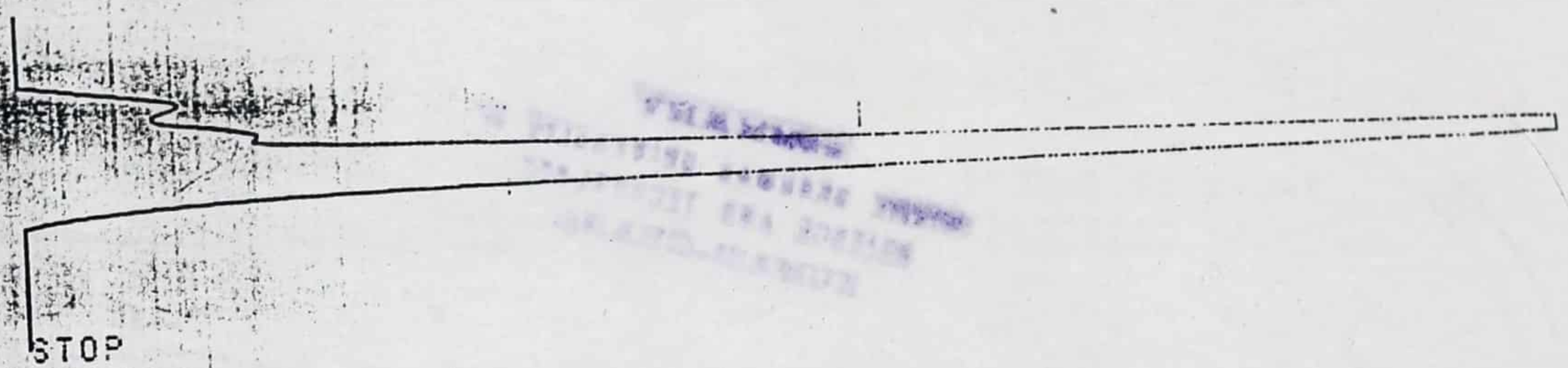


STOP

CHROMATOPAC C-R6A
SAMPLE NO 0
REPORT NO 45836
STANDARD 3

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	3.023	191527				3-CAR
	TOTAL	191527				

START

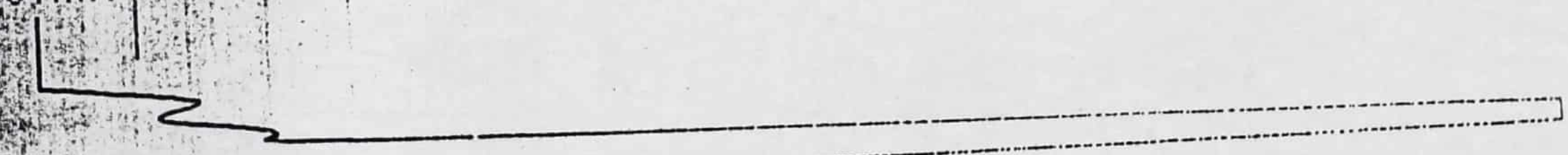


STOP

CHROMATOPAC C-R6A
SAMPLE NO 0
REPORT NO 45837
STANDARD 2

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	3.003	191021				3-CAR
	TOTAL	191021				

START



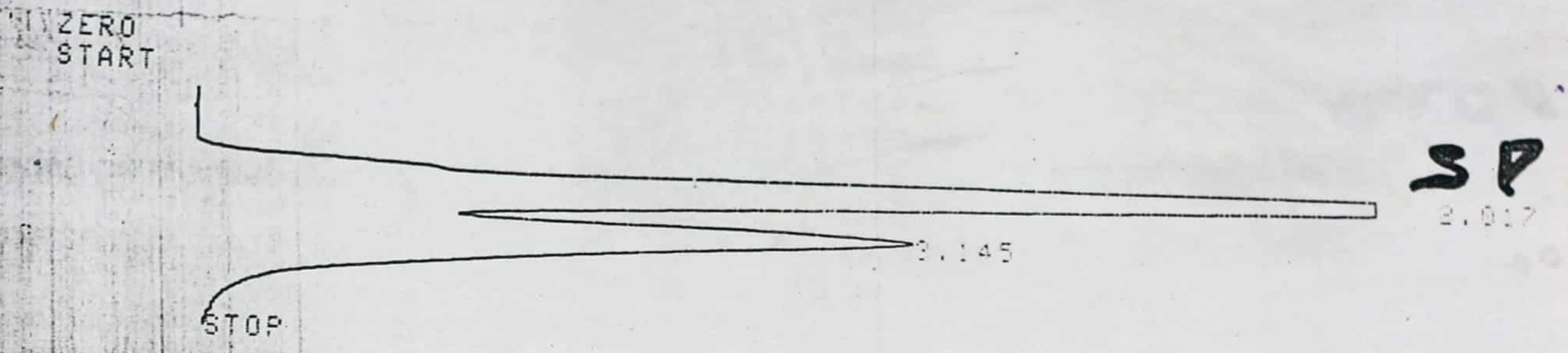
STOP

CHROMATOPAC C-R6A
SAMPLE NO 0
REPORT NO 45838
STANDARD

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	3.033	200244				3-CAR
	TOTAL	200244				

CALIBRATION MADE IN IDENTIFICATION FILE 4
MODE 3

IDNO	NAME	TIME	BAND	FACTOR
	3-CAR			

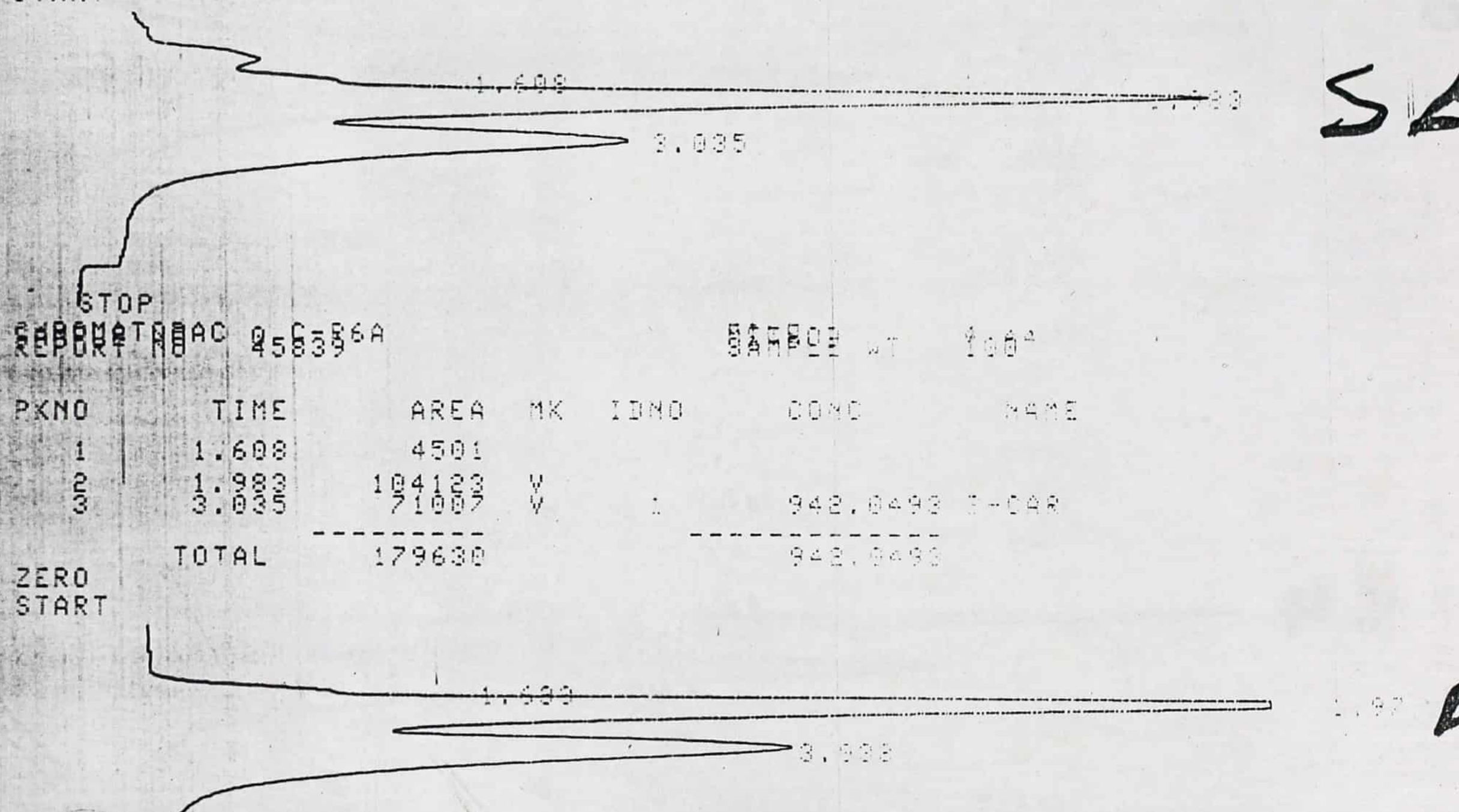


SP

CHROMATOPAC C-R6A
SAMPLE NO 0
REPORT NO 45851

FILE 4
METHOD 44
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	2.017	186821				
2	3.145	115615	V	1	1533.8681	V-CAR
TOTAL		302436			1533.8681	



SA

CHROMATOPAC C-R6A
REPORT NO 45839

SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	1.608	4501				
2	1.983	104123	V			
3	3.035	71005	V	1	942.0493	V-CAR
TOTAL		179630			942.0493	

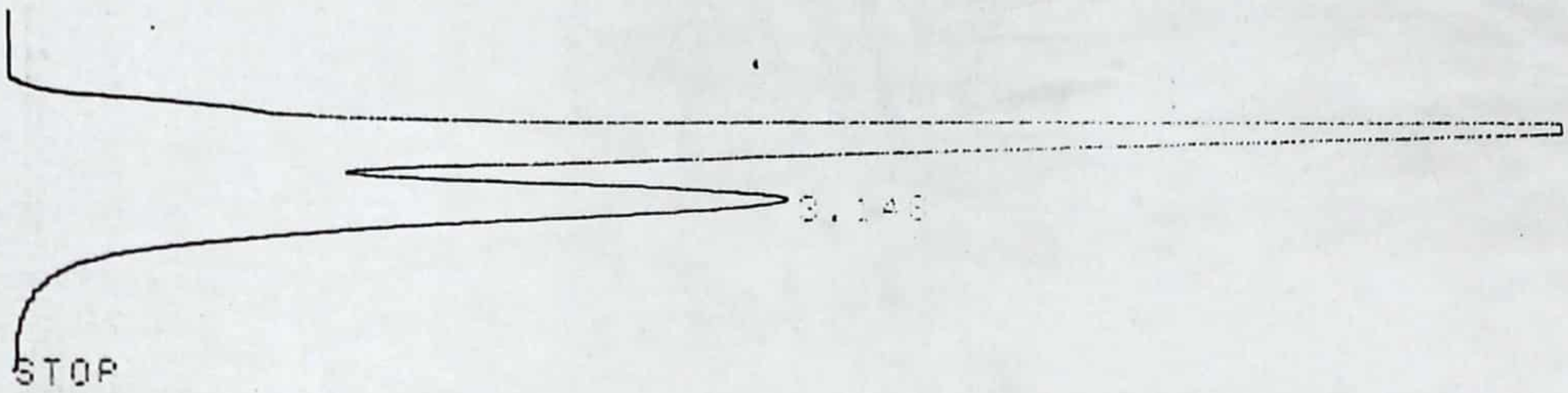
A

CHROMATOPAC C-R6A
REPORT NO 45840

SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
2	1.633	4501				
3	3.038	234316	V	1	1366.6197	V-CAR
TOTAL		238817			1366.6197	

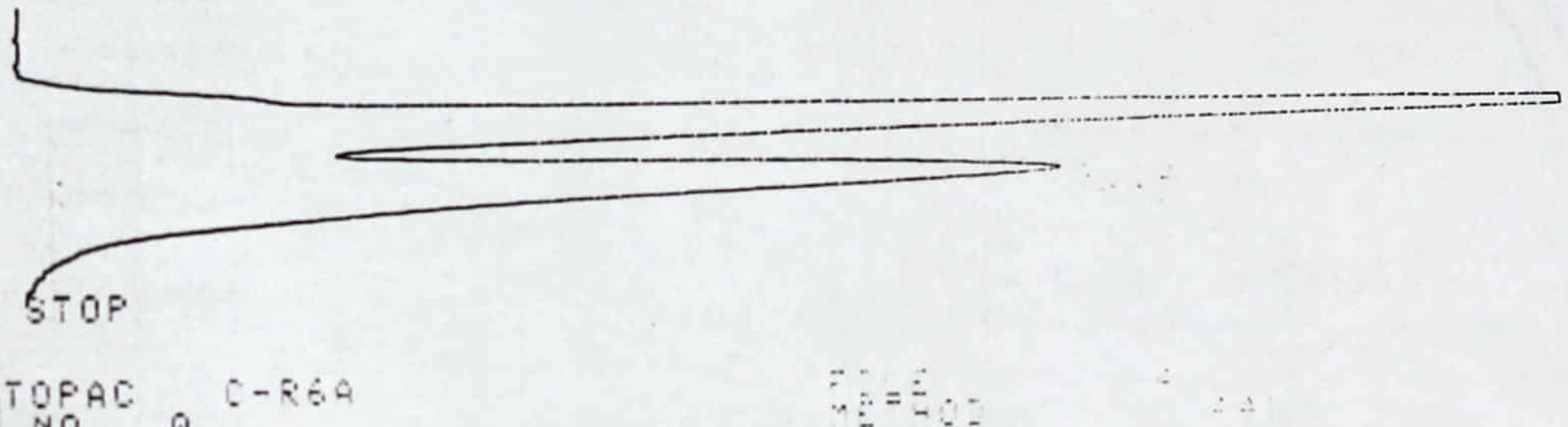
ZERO START



CHROMATOPAC C-R6A
REPORT NO 45844

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	2.017	148490				
2	3.148	97084	V	1	1288.18	S-1A
	TOTAL	245574			1288.18	

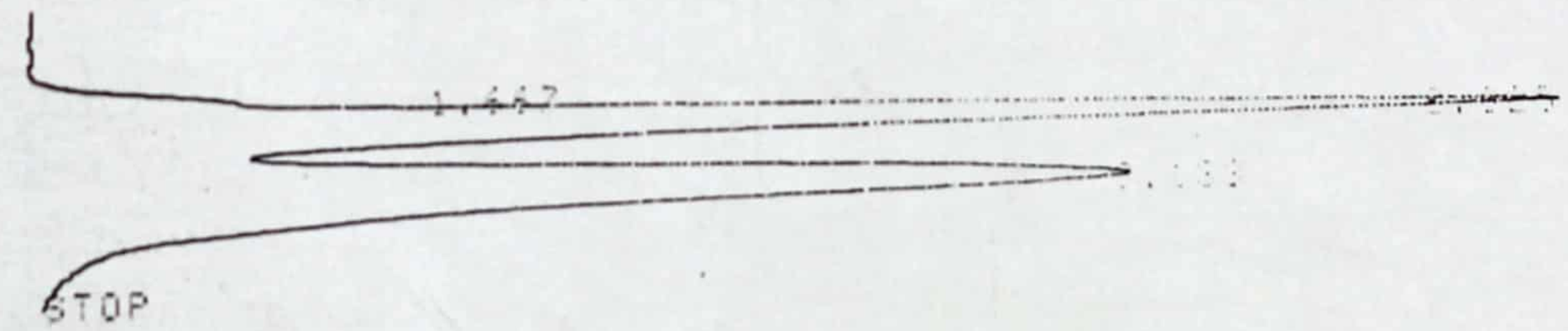
ZERO START



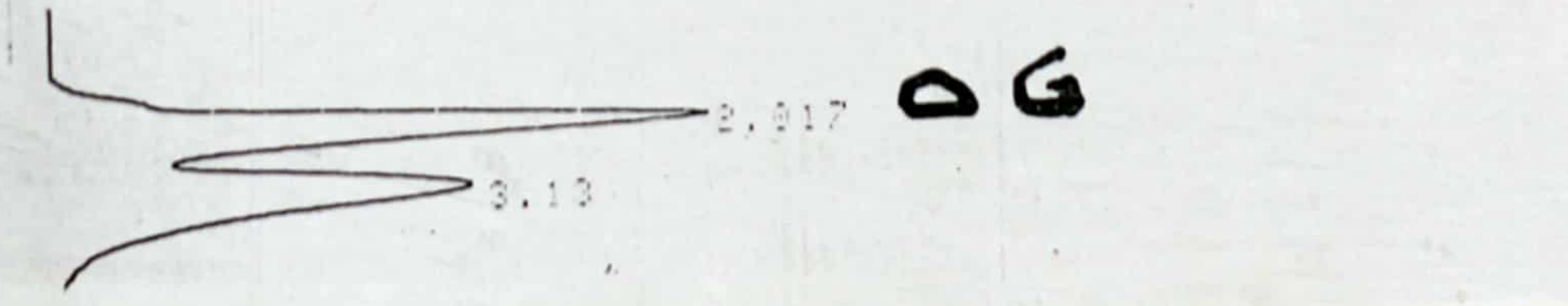
CHROMATOPAC C-R6A
SAMPLE NO 0
REPORT NO 45843

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	2.047	150110				
2	3.14	121047	V	1	[illegible]	[illegible]
	TOTAL	271158			[illegible]	

ZERO START



CHROMATOPAC C-R6A
REPORT NO 45844

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	1:055	[illegible]				
2	2:135	[illegible]	V	1	[illegible]	S-1B
3	3:133	[illegible]			[illegible]	
	TOTAL	[illegible]			[illegible]	

ZERO START