

**QUALITY OF DEEP FRIED CHIP COOKING OIL
AT FAST FOOD OUTLETS IN THE SOUTH CENTRAL
OPERATIONAL ENTITY WITHIN
ETHEKWINI MUNICIPALITY**

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ABSTRACT

The demand for deep fried chips by public and the number of people entering the fast food industry in the form of fast food outlets has increased tremendously. Frying oils are very expensive and are the most important ingredient used in the preparation of fried foods. Due to high oil costs and lack of knowledge, frying oils are used to their maximum. This has resulted in the abuse of deep fried chip cooking oils. The overall quality of the deep fried chip cooking oil used in the South Central Operational Entity of the eThekweni Municipality is not known but abused cooking oils have been identified by Environmental Health Practitioners (EHP's) during routine inspections of fast food outlets.

Considering all of the above, the objectives of the proposed research were:

- (1) Determine the overall prevalence of the use of abused deep fried chip cooking oils at fast food outlets in the South Central Operational Entity of the eThekweni Municipality.
- (2) Determine in which supervision areas in the South Central Operational Entity the use of abused cooking oil is most prevalent.
- (3) Determine current/reported practices in preserving the quality of chip oil.
- (4) Make appropriate recommendations to owner/managers of the fast food outlets and to Environmental Health Practitioners.

The study design was observational utilizing a Rapid Epidemiological Assessment (REA) technique, with both a descriptive and analytical component.

All fast food outlets making deep fried chips in the South Central Operational Entity registered with the eThekweni Health Department at the time of the study were included in the study population. The Lot Quality Assurance Sampling (LQAS) method was used to determine the overall prevalence of the use of abused oil and to determine supervision areas reached the predetermined service target. A total of 100 fast food outlets were sampled.

An oil sample from each fast food outlet, which was taken and sent to a laboratory where an Oxifrit Test was done on every oil sample taken. The Oxifrit Test was the benchmark in this study. EHP's of eThekweni Municipality collected further data by means of an observational

checklist and a closed-ended questionnaire, which aimed to establish cooking oil preservation practices.

The study revealed that 60 of the outlets had oil that was acceptable whereas 40 had oil that was unacceptable (abused oil).

In the multivariate analysis the only factors significantly associated with abused oil were the condition of the fryer and frequency of oil change.

Supervision Areas 6, and 4 had more abused deep fried chip cooking oil than average in the South Central Operational Entity.

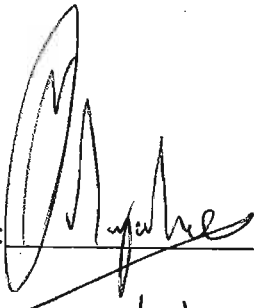
For further prioritization, Supervision Areas 6 and 4 fell below the decision rule for majority of acceptable oil preservation practices, thus Supervision Areas 6 and 4 will be targeted for intervention.

Intervention will include education, monitoring and ultimately enforcing the law by EHP's to ensure safe use of deep fried chip cooking oil in the South Central Operational Entity within eThekweni Municipality.

DECLARATION

I, THERESA PADAYACHEE, do hereby declare that this dissertation is the result of my own investigation and research and all primary and secondary sources have been acknowledged. It has not been submitted in part or full for any other degree to any other University.

SIGNATURE: _____



DATE: _____

2006/12/15

SUPERVISOR

SIGNATURE: _____



DATE: _____

15 December 2006

DEDICATION

This dissertation is dedicated to my dearest parents, Mr and Mrs N Padayachee and to my loving husband, Nelendran Pillay, who has been a source of inspiration and motivation from the commencement of this endeavor up until its completion.

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I thank dear God, who is the head of my life and without whose constant help this study would not have been possible.

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ACRONYMS AND ABBREVIATIONS

AIDS	- Acquired Immunodeficiency Syndrome
CI	- Confidence Interval
DSW	- Durban Solid Waste
EHP's	- Environmental Health Practitioners
HIV	- Human Immunodeficiency Virus
LQAS	- Lot Quality Assurance Sampling
OR	- Odds Ratio
p	- p Value
PAHs	- Polycyclic Aromatic Hydrocarbons
PC	- Polar Compounds
PCB	- Polychlorinated Biphenyl
PTGs	- Polymerized Triglycerides
REA	- Rapid Epidemiological Assessment
SAFOI	- South African Fryer Oil Initiative
SD	- Standard Deviation
SE	- Standard Error
SOS	- Super-Oxidated Oils
TOS	- Toxic Oil Syndrome
UK	- United Kingdom

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CHAPTER 1

INTRODUCTION AND OVERVIEW OF THE STUDY

1.1 INTRODUCTION

The extended use and overheating of frying or cooking oils causes a build up of chemical impurities which may cause diarrhea, contribute to hardening of arteries, damage the liver and kidneys and lead to cancer. Research conducted by the Department of Health in South Africa has shown that a large portion of cooking oils from fast food shops, corner shops and restaurants are unacceptable for human consumption or even poisonous. Such oils are often sold or even donated to underprivileged persons. The problem is considered to be serious and widespread and can only be controlled by means of a multi-disciplinary approach.¹

Surveys launched across South Africa, indicate that many frying establishments abuse their frying oils and fats during the frying process resulting among others in the degradation and concomitant production of potentially unhealthy oxidation products.² This is mainly caused by the repeated use of oil in order to save money. In many cases restaurant oils are also sold to the poor communities where it is further broken down through repeated usage to levels that poses a health threat. These breakdown products have been shown to be hazardous to human and animal health and should therefore not be incorporated into animal feed or re-used for human consumption.³

Consequently, strict regulations under the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act 54 of 1972) were published on 16 August 1996.² It is now an offence to use or sell for human consumption used cooking oil or fat, which contains high levels of these degraded products.²

If strict quality management systems are applied by oil collectors at frying establishments, mainly fast food outlet and restaurant oils within regulatory limits will be used in food preparation. These oils are regarded safe for use in human and animal feed.³

The quality of the deep fried chip cooking oil used in the South Central Operational Entity of eThekweni Municipality is not known but abused cooking oils have been identified by Environmental Health Practitioners during routine inspections of food premises.

1.2 DEFINITION OF TERMS

Fast food outlet: is an off-consumption take away premises used for the preparation, display and sale of food in conjunction with a food business.

Chips: fried potatoes, which are characterized by a crispy, crust surface layer of about 1-2mm thick where most of the oil is located and a soft crumb interior. They are usually sliced evenly lengthwise and are approximately between 6,4 to 12,7 mm thick.⁴

Deep frying: Process of immersing food in hot oil with the aim of sealing it so that all the flavour and juices are retained in a crisp crust.⁴

Fats: refer to fats of animal origin.⁴

Oil: refer to fats of plant origin.⁴

Abused cooking oil: Oil that has been repeatedly reused and whose total percentage of polar compounds has exceeded 25%.⁴

Supervision Area: Jurisdictional geographical area allocated to an Environmental Health Practitioner for daily supervision.

1.3 The Setting: The North and South Central Operational Entity of eThekweni Municipality

The North and South Central Operational Area is the largest area of the 5 operational entities, which make up the eThekweni Metropolitan Council area. The five entities are Outer West Council, Inner West Council, North Council, South Council and the North and South Central (see Annexure 01: Map of eThekweni Municipal Boundary). It accommodates about 1 800 000 people which is about 60% of the total Municipal



population.³ The racial composition of the area is diverse with 63% of the population being African, 22% Indian, 12% White and 3% Coloured. The population is extremely young, with 36% being under 20 years. There is a growing elderly population where there are presently 6,2% of the population over 60% years of age. The high HIV prevalence in the province is likely to have a significant impact on the structure of the population over time.⁵

Poverty is extremely high in the area, with over 50% of the economically active portion of the population earning less than R1000 per month. Less than 2% of the population earn over R6000 per month. This has a significant impact on the percentage of the population utilizing public health services, as well as the overall health status of population.⁴ For the purpose of my study the South Central Operational Entity only was investigated because this is the area in which I work in and thus wanted to ensure that quality of deep fried chip oil at fast food outlets are safe for consumption. The suburbs within the South Central Operational Entity were divided into 6 supervisory areas (Annexure 02).⁵

The majority of the residents in the South Central Entity are Asian and Whites. The dwellings are of the sub-economic type. The North and South Central Operational Entity has approximately 3489 food processing premises which includes fast food outlets, restaurants, bakeries, food manufacturers, butcheries, flea market stalls, and home industries. The eThekweni Health Department has a regulation and educational role in monitoring compliance with health requirements which include general inspections; bacteriological sampling of ready to eat food; health education on food hygiene practices and where necessary taking legal action against offenders.

1.4 Overview of eThekweni Health Department

In fulfilling the KwaZulu - Natal Provincial Health Department's vision of "Optimal Health for All" the mission of the eThekweni Health Department is to provide "an effective, efficient, acceptable, affordable, accessible and equitable comprehensive primary health care service within the context of the District Health System". The work of the Department is divided into 5 key programmes which are designed to meet identified issues or challenges.⁵ These programmes include Communicable Disease;

Environmental Health; Personal Health, Health Promotion and the Management and Administrative Services.⁵

1.5 **Overview of Environmental Health Services**

The Environmental Health Services programme responds to the environmental threats from increased incidence of informal urban settlements, increase in informal trading, complexity of industries in the area, industrial development, urban development, hazardous waste products, which threaten human health, as well as environmental sustainability and health. The overall goal of this service is to ensure all activities and development in the living; working, recreational and built-up environments are safe and environmentally sustainable.⁵

8 projects, which form part of the Environmental Health Service programme:

- a) Food Safety Section;
- b) Physical Development;
- c) Informal Trade;
- d) Residential, Recreational and Commercial Environments;
- e) Pollution Control;
- f) Environmental Health Assessments in Southern Industrial Basin;
- g) Industrial Impact Management and Occupational Health;
- h) Child Care Facilities and Institutions.

As an Environmental Health Practitioner working in the Food Safety Section, my role in the eThekweni Health Department has a regulatory and educational function in monitoring compliance with health requirements, which include general inspection, bacteriological sampling of ready to eat food, health education on food hygiene practices and where necessary, and taking legal action against offenders.

1.6 **Overview of Food Safety in Terms of Environmental Health Services**

The Divisional Manager for Food Safety in North and South Central Operational Entity is responsible for the overall supervision of Food Control. The goal of the Food Safety Department is to ensure that statutory health and safety standards are applied, that a safe and wholesome supply of food is available from food outlets in the area, and to reduce the incidence of food poisoning. The department undertakes the routine

monitoring of all food premises, sampling of foodstuffs, food condemnations, investigation of reported incidence of food poisoning and responds to public complaints about food and food premises. The department attempts to educate food premises owners, and food handlers in order to ensure compliance with the standards but where there is continued non compliance, legal channels are resorted to. In addition the Department operates a Bacteriological Laboratory where food (including water, used cooking oil, milk and milk products) is analyzed in support of food control.

1.7 Background to Study and Problem Statement

1.7.1 Background to Study

Attempts by some frying establishments to bring about savings in frying oil cost have resulted in various abusive practices. These include adulteration and over-oxidation. Adulteration includes the addition of mineral oils in order to increase oil volume and usage.²

Over-oxidation of frying oils and fats on the other hand, is caused by too high temperatures in the fryer, extended heating time, repeated usage (in order to make oil last longer) and topping up of over-oxidized oils with new oil. In this case, free radicals formed in the old oil can initiate a chain reaction causing increased oxidation of the new oil thereby decreasing its usable life.²

One of the first reports on these practices come from South Africa, Durban, in 1938 when several people became ill due to the consumption of contaminated table oil.² The occurrence of abused edible oils is not a problem unique to South Africa. Many other countries have experienced the effects of the “cooking oil crisis”, namely Chile in 1958 more than 800 people died due to toxic oil. In United States of America oil was contaminated with tryptophan metabolites (amino acids which become toxic in high concentrations) and 2 800 people were affected and 712 died, in 1989.⁴ Another well known tragedy is the Toxic Oil Syndrome (TOS) which occurred in 1981 in Spain, more than 20000 people became ill while 600 died due to the consumption of unmarked contaminated oil.²

According to a survey conducted by Kock *et al* in 1994 in collaboration with the Department of Health showed more than 30% of frying establishments in South Africa abused cooking oils, which may pose a threat to health. The proportion of polar compounds was as high as 60% whereas polymerized compounds constituted as much as 70%.⁶

Thus it can be noted that many disasters were caused simply by the fact that the cooking oil was not suitable for consumption.

1.7.2 Problem Statement

Abused cooking oils have been identified by Environmental Health Practitioners during inspections of the food premises. The reason for conducting the study is that the overall quality of the deep fried chip cooking oil used and the extent of the use of abused frying oil in the South Central Operational Entity of eThekweni Municipality is not known. Poor enforcement of the legislation by EHP's is also a contributing factor to the number of facilities using abused cooking oils. No legal action has been taken against food premises for selling abused cooking oil for consumption, which contains high levels of polar compounds and Polymerized Triglycerides. No warning notices have been served on offenders to comply with legislation of foodstuffs, Cosmetic and Disinfectants Act, 1972 (Act 54 of 1972) published on 16 August 1996 with regards to abused cooking oil. Only two random oil samples per month per EHP are brought to the Laboratory for testing.⁶

1.8 Purpose of Study

To determine the quality of deep fried chip cooking oil at fast food outlets and to determine where the use of abused oil is most prevalent, with a view to targeting EHP's resources and actions in the South Central Operational Entity within eThekweni Municipality.

1.9 Hypothesis

It was hypothesized that fast food outlets in the South Central Operational Entity are using abused deep fried chip cooking oil.

1.10 Objectives

- (1) Determine the overall prevalence of the use of abused deep fried chip cooking oils at fast food outlets in the South Central Operational Entity of the eThekwin Municipality.
- (2) Determine in which supervision areas in the South Central Operational Entity the use of abused cooking oil is most prevalent.
- (3) Determine current/reported practices in preserving the quality of chip oil.
- (4) Make appropriate recommendations to owner/managers of the fast food outlets and to Environmental Health Practitioners.

1.11 Summary Outline per Chapter

- (1) Chapter one gives an introduction and general overview of the study. It focuses on the research problem, the importance of the study and background to the organization.
- (2) Chapter two highlights a detailed literature review. This section covers the legal requirement, origin of deep frying and French fries, degradation of oil looking at chemical and physical changes during frying process. Chemical testing available to test quality of oil and its biological effect on health.
- (3) Chapter three discusses the research methodology. It also explains study design. Data collection method and the data analysis that will be undertaken to analyse data.
- (4) Chapter four presents the results and reports on the findings. Frequency tables and correlations are presented through the use of graphs and tables.
- (5) Chapter five interprets the results present in chapter four. The results are discussed in relation to South Central Entity within eThekwin Municipality.
- (6) Chapter six discusses the conclusion drawn from the research study. It also offers recommendation on how to improve the quality of oil. Recommendations are also offered for further research.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In South Africa, fried food is a major item in the diet of many people.⁶ This has resulted in large quantities of frying oil and fat being used and consumed by our community. Attempts to bring about savings in the cost of frying oil have resulted in large quantities of oil being heated repeatedly over long periods and hence becoming severely oxidized (abused).⁶

Other abusive practices include the addition of mineral oils in order to increase oil volume and the indiscriminate refining of abused oils by adding substances such as lime and bleaching agents. In Spain, in 1981, 600 people died and more than 20 000 became ill as a result of unlabelled refined cheap toxic cooking oils.⁷

Investigation into cooking oil intensified in the early 1990s when, internationally, it was confirmed that high temperatures, repeated use and prolonged heating result in its over-oxidation and the formation of hazardous breakdown products such as Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyl (PCBs). These have been linked to cancer, atherosclerosis, diarrhea, and oxidative stress, enlargement of the liver and spleen, and retarded growth, among others. There is speculation, too, that the consumption and/or inhalation of super-oxidated oils (SOS) could advance the progression of HIV/AIDS.⁸

By 1994, numerous countries had already introduced legislation to prohibit the use of oils with a total polar compound (PC) content of 25% or more. Other countries use polymer content (varnish-like compounds) as a guide to oil degradation. In these cases, a level of 16% polymerized triglycerides (PTGs) and above are regarded as harmful.⁸

In South Africa, Kock, his colleagues and Environmental Health Officials found dangerous levels of PCs and PTGs during an extensive survey conducted among 54

frying establishments in the Free State. In addition to this, they discovered that 88% of the businesses surveyed redistributed already abused oils to the informal sector for re-use, primarily via their employees. These 'fish oils' or SOS products are consumed, often after further additional rapid oxidation, with prepared food, while the corresponding volatiles are inhaled during processing. Further evidence showed that over-used oil was sometimes treated with unhealthy chemicals, such as bleach, and resold as new oil, either on its own or as a blend with other oils.⁸

The initial study mobilized the National Health Department to draw used oil samples throughout South Africa. Findings confirmed that action was required with many samples registering dangerous PC and PTG levels. In August 1996, final regulations were published in the Government Gazette, prohibiting the use and sale of edible oils unless they contain less than 16% PTGs and/or 25% or less PCs.⁸

While it is clear that there is still reason for concern in South Africa, much has been done since 1996, and is ongoing, to reduce and rectify this situation.⁸

2.2 LEGAL REQUIREMENT

Special provisions were made in the regulation, which applied to the edible fats and oils, and mixtures thereof which were intended for final consumption and catering purposes or which were used as ingredients in the manufacture of foodstuffs. These provisions were:⁹

1. There is to be no mineral oils present in edible fats and oils. The edible fats and oils may contain antioxidants as permitted by Government notice dated 3 June 1977 and colourants as permitted by Government notice dated 6 May 1977 and amended on 9 September 1983. The standards for the purity and composition of fats and oils are those laid down in the latest edition of Codex Alimentarius Standards for Fats and Oils for the British Pharmacopoeia.⁹
2. The edible fats and oils, which were used for the frying of foods, were deemed to be harmful or injurious to human health unless they contained less than 16% polymerized triglycerides and/or 25% polar compounds.⁹

The lack of the enforcement of the abovementioned legislation could be one of the contributing factors responsible for the abuse of cooking oils at fast food outlets.

2.3 **ORIGIN OF DEEP FRYING**

Deep frying is one of the processes of food preparation. For decades consumers have desired deep fried products because of their unique flavour. Some of these are potato chips and French fries. The technology originated and developed around the Mediterranean area, due to the influence of olive oil. Today, deep fried foods are found all over the world. The aim of deep frying is to seal the food by immersing it in hot oil so that all the flavour and juices are retained in a crisp crust.⁴

Frying should be done when the oil is in the fresh to optimum phases to obtain good-quality foods. An oil should be discarded when it matches a certain colour or when visibility is impaired at a defined distance. An oil should also be discarded if it has a rancid or off odour.⁴

2.4 **FRYING AND FRYING SYSTEMS**

Frying is considered to be one of the oldest cooking methods in existence. It is often selected as a method of choice for creating unique flavors and texture in processed foods. The immersion frying process, also called deep fat frying, is commonly used by the multimillion-dollar snack food industry. Between 1979 and 1988, the snack food industry in the United States increased by about 88%.¹⁰

Despite the widespread use of the frying process, research on the engineering aspects of frying has been limited. An understanding of the complex processes that occur during frying is necessary to control the quality of the final fried product.¹⁰

Frying is a complex and important operation in the industrial or institutional preparation of foods. Despite the fact that vast amounts of foods are produced by this method, frying is still considered by many to be more of an art than a science or technology. Deep fat frying involves transfer of heat from the surrounding oil to the interior of a food product. Several chemical and physical changes occur during frying, including starch gelatinization, protein denaturation, water vaporization, and crust formation. In addition to heat transfer, mass transfer takes place. It is characterized

by the movement of oil into the product, and movement of water in the form of vapor from the product into the oil.¹⁰

The development of continuous frying systems progressed rapidly over the years to reduce customer maintenance cost, and improve food quality and longer oil life. The measures of quality in frying operations relate to the gentleness of the product handling through the fryer and the uniform and consistent application of heat to achieve the required temperature profiles. Optional skimming devices at the discharge end continuously remove floating particles that might otherwise remain in the hot oil and become char specks. Those floating char specks can cause rapid oil quality deterioration.¹¹

2.5 ORIGIN OF FRENCH FRIES

French fries were prepared in Belgium in the seventeenth century by peasants who, during the winter, were looking for a food substitute for their unavailable staple fried fish. The French called fries “pommes frites”, meaning fried potatoes. In America they are called “French fries” probably because they gained real popularity after World War I when soldiers enjoyed the fries they had in France. The structure of French fries is characterized by a crispy crust (surface layer) of about 1 – 2 mm thick where most of the oil is located, and a soft crumb (interior).⁴

2.6 DEGRADATION OF OIL

Physical and Chemical Changes in Oil During Frying Process

Desirable frying oil must be low in free fatty acids and polar compounds and must have a high breakdown resistance during continuous use. Hence, a thorough understanding of oil degradation and the effects of degraded oil on the quality of the final product are important. Frying oil degrades with continuous use. In the frying process the food is submerged in oil heated in the presence of air. The oil is exposed to the action of four agents that cause drastic changes in its structure, namely:

- (a) Moisture from the food, giving rise to oil break down that may lead to oxidation;
- (b) Atmospheric oxygen entering the oil from the surface of container, gives rise to oxidation alteration;

- (c) High temperature at which operation takes place results in thermal alteration;
- (d) Contamination by food ingredient.

The existence of the degradation compounds in the frying medium results in a series of physical and chemical changes, some of which are easily observed and are as follows.

- (a) Variation in organoleptic characteristics, caused by the development of aromas and tastes typical of fats and oils heated to high temperatures when foods are fried in them.
- (b) An increase in the viscosity and density of the oil as a result of polymerization reactions.
- (c) The darkening of the frying medium due to the presence of unsaturated carbonyl compounds or to non-polar compounds of food soluble in the fat.
- (d) The tendency of foam formation also related with polymerisation products and amphophilic substances from the foods.
- (e) The increase in acid value due to hydrolytic reactions.
- (f) The decrease in iodine value due to the breakdown of the double bonds caused by polymerisation and cyclization reactions ¹².

When a moist food is placed in oil at high frying temperatures, air and steam are evolved initiating a chain of interrelated reactions. The natural triglycerides comprising an oil or fat and considered to be non-polar material are hydrolysed by the steam, resulting in the formation of free fatty acids, monoglycerides, diglycerides, glycerols and oxidised triglycerides, while the air released in the frying system initiates a cycle of oxidation reactions resulting in the formation of free radicals, oxidised monomers, oxidative dimers and polymers, non-polar dimers and polymers; volatile compounds such as hydrocarbons, aldehydes, ketones, alcohols and acids and finally the high frying temperatures applied on the oil results in the formation of cyclic monomers, dimers and polymers.¹³

Some of these volatile or non-volatile compounds, which are soluble in the oil, are defined as polar compounds. The repeated and intermittent heating and cooling process of the frying oil also increases the degradation of the oil, probably owing to

peroxide formation and decomposition during the heating, frying and cooling cycles. It has been claimed that a frying fat or oil, which has a polar content of over 25%, is unfit for further use and must be discarded.¹³

During the frying process the concentration of the degraded products gradually increases and the quality of the oil deteriorates until it is unfit for further use. The quality of the food fried in the oil correspondingly decreases until it is unacceptable. Several countries have placed legal limits on the amount of total polar material that may be present in oil used for deep fat frying.¹³

It is common practice for restaurant owners and managers to filter the oil used for deep fat frying to remove food debris, which may accelerate the decomposition of the oil. The removal of food debris alone is known as passive filtration and the removal of soluble impurities by absorption is known as active filtration. A much better quality of fried food is obtained and the life of the frying oil is extended even further after the frying oil undergoes both active and passive filtration.¹³

Lipid oxidation is a normal biological process during which energy is obtained from the fat. Oxidation reactions that occur in foods are referred to as autoxidation and similar reactions that take place in the body are referred to as peroxidation. Both of these oxidation reactions are harmful to health.¹⁴

Highly oxidised foods possess a rancid smell or taste and, therefore, people will avoid consuming such foods. On the other hand, foods that are slightly or moderately oxidised are not discarded but consumed. The question is how much of this slightly oxidised food can be consumed before becoming concerned of its harmful effects to health. There have been no reports published or any research carried out to determine as to what amount of the oxidation products, after having been consumed, will cause ill health.¹⁴

Lipid oxidation causes a loss of the essential and natural fatty acids found in foods. Nutritional value of foods as well as flavour deterioration, impaired colour and texture and highly oxidised foods have a negative effect on health.¹⁴

Unsaturated fatty acids are the main targets of oxygen attack in addition to other compounds such as sterols, carotenoids and aromatic compounds. The reaction between oxygen and lipids does not take place spontaneously, but instead, it is initiated either by the formation of free radicals from the lipids or by the formation of active oxygen species that are able to react directly with the lipid molecule.¹⁴

Some of the factors that contribute to the oxidation of the foods are enzymes, metal and metal compounds, light and heat. Oxidation can also occur in raw materials and during the processing of foods. In order to control the rate of oxidation, it is essential to limit the amount of oxygen and light during the processing and packaging of foods. Other methods to limit the rate of oxidation is to render the enzymes inactive, store the foods at low temperatures or to add an antioxidant in the frying oil or fat during the frying process.¹⁴

Lipid oxidation occurs very rapidly in deep fat frying because of the high temperatures which these oils and fats are subjected to. Lipid oxidation remains a major problem in the food industry and an important cause of food quality deterioration.¹⁴

It has been shown that thirty percent of the frying medium is oxidized after only 72 hours of frying and that rats, having been fed with highly oxidized frying fat showed a decrease in growth, an increase in liver weight and deposits of fatty tissues.¹⁴

In another animal study the ingestion of oxidized abused fats caused oxidative stress and a variety of biological effects.¹⁵

Polyunsaturated fatty acids are susceptible to attack by free radicals and oxidation into lipid peroxides and consequently contribute to inflammation and oxidative stress. The main dietary source of polyunsaturated fatty acids is sunflower oil. It was speculated that although HIV-infected subjects in a study population were asymptomatic, they were more vulnerable to liver damage by polyunsaturated fatty acids, because of increases oxidative stress than were uninfected subjects. Because HIV-infected subjects are already vulnerable to lipid peroxidation and oxidative stress, which are related to the progression of HIV and AIDS, it is extremely important to minimize their exposure to harmful substances.¹⁵

Lodewyk F Kock raised some concerns about the abovementioned speculation that polyunsaturated fatty acids maybe misinterpreted as being unsafe. It must be noted that the oxidative load associated with the dietary fat intake in the abovementioned study was not measured. Such a study is however needed because South Africa is plagued with a high prevalence of HIV infection.¹⁶

Toxic substances can also be present in recycled cooking oils, which are used, for animal feeds. Accumulation and persist contamination undergo biomagnification effect increasing their concentration all along the food chain. The most important characteristics of PCBs, dioxins and dioxin-like compounds are that they are very liposoluble, poorly degradable and relatively volatile. Other liposoluble compounds accumulating in foods are PAHs. They are also a group of substances, which may constitute a significant public health problem. The practical management of limiting the presence of PAHs in cooking oils is by controlling high temperatures and avoiding volatilization.¹⁷

2.7 NATIONAL AND INTERNATIONAL SURVEYS

The Laboratory of the Government Chemist, in collaboration with the UK Ministry of Agriculture, Fisheries and Food, conducted a survey in the London area and analysed 50 used and 50 unused frying oil and fat samples from almost 100 cafes, restaurants, hospitals and school kitchens. The average polar compound concentration determined in the unused frying oil samples ranged from 0.4% to 6.4%, whereas, the used frying oil samples had a polar compound content in the range from 4% to 46%.¹³

The harmful effects of polar compounds from the abused frying oils have been studied for more than 40 years. Researchers have found that the intake of abused frying oils with a concentration of more than 50% total polar compounds has been responsible for many diseases and sickness. These overheated abused frying oils caused severe irritation of the gastro-intestinal tract, diarrhoea, and growth retardation and in some cases even death when they were fed to animals. On the other hand, the Unilever Laboratory in Germany performed experiments over a period of 10 years by feeding animals with frying oils which were heated under controlled temperatures and hygienic conditions and containing between 10 and 20 percent polar compounds

showed no adverse effects. Results from these experiments had shown that the animals did not experience any ill effects even with the addition of large amounts of the frying oils in the diet.¹³

The German Society for Fat Research and the Unilever Laboratory in Germany, having performed research on over 400 used frying oil samples, recommended that frying oils and fats containing more than 30% total polar compounds should be regarded as being deteriorated and therefore unfit for human consumption. This limit of 30% polar compounds in frying oils has been generally accepted as the point at which the frying oil is definitely unfit for further use, but rather, to be discarded.¹³

The Lipid Biotechnology Laboratory of the Department of Microbiology and Biochemistry at the University of the Orange Free State and the Environmental Health Division of the Municipality of Bloemfontein conducted a survey, similar to that conducted by the Laboratory of the Government Chemist and the UK Ministry of Agriculture, Fisheries and Food in the London area, in the quality of used frying oil from 54 cafes, restaurants and similar establishments.¹³

The total polar compound concentration determined in the 54 used frying oil samples ranged from 1% to 57%. 37 samples had a concentration of less than 30% total polar compound which, according to the Unilever Laboratory in Germany, was the acceptable limit and 17 of the samples had a concentration of more than 30% total polar compound which indicated that these frying oils had deteriorated, and therefore, according to the Unilever Laboratory in Germany, were unacceptable for human consumption. A matter of great concern was that 6 samples had a concentration of more than 50% total polar compound indicating that these frying oils were extremely abused.¹³

According to the same survey conducted by the University of the Orange Free State, 15 of the 17 used frying oils containing more than 30% total polar compound were either sold or given to employees or people from the underprivileged communities in the Bloemfontein area for further use in the frying of foods. The survey also indicated that about 250 tons of frying oil are used annually in the Bloemfontein area.¹³

A survey of the quality of used frying fats in food frying establishment conducted in 1996 and 1997 in South Africa revealed of the 869 samples taken from the Pretoria area, 11.7% had reached the end of their usable life and was due for replacement by using Oxifrit test. The Oxifrit was chosen since there is a relatively high correlation with polar compound content. Of the remaining 784 samples taken from other regions it was clear that all regions have frying establishments that are using over-oxidized frying oils.¹⁸

In view of the health implications, international bodies have issued recommendations about legal provisions, which regulate the use and maximum life of oils and fats subject to frying. The most commonly accepted system for control is parameter called Total Polar Compounds (must be < 25% in Spain, Belgium, Czech Republic, France and Italy, <27% in Switzerland, Austria, and Germany, and <30% in Hungary).¹⁷

Furthermore, some studies carried out actual samples from cooking oil establishments in France (n=31), Spain (n=174), and Germany (n=124) provide useful information for assessing what might be the normal values found in discarded cooking oil. 40% of the abovementioned cases discarded oils exceeding 25% polar compounds, which is the limit, established by legal regulation. This lead to the conclusion that the quality control of frying oils is essential. Another interesting conclusion is that in many establishments there is a lack of knowledge of the frying process, together with incorrect procedure for changing oil, frying temperature and selection of conditions regarding oil used.¹⁷

2.8 OIL ACTION

A first mean of control for all agents is to have quality control. This will ensure traceability and minimum variability in obtaining standard quality of fat and oils. Cooking oil recycling companies also play a significant role in guaranteeing the quality and also origin of the oils they used. They should be obliged to establish a quality control system, which allows for the necessary traceability of the end product so obtained. They must hold appropriate certification from their countries authorities, which ensure companies analyses all the risks involved in the operation. Directive 75/442 on waste is the only directive, which regulates cooking oils but in a non-

specific manner, establishes the obligation for all Member States to control companies responsible for the collection and handling of this waste.¹⁷

Since 1995, the South African Fryer Oil Initiative has mobilized a network of participants to embark on an ongoing awareness campaign. Participants include members of the SA Oil Processors Association, Malaysian Palm Oil Industry, SA Olive Growers Association, and Health Departments across the country, frying establishments, used oil collectors, animal feed mills and the South African Police. The health hazards with regards to using abused oils have been communicated to millions of people. EHP's draws oil samples from establishments across South Africa on an ongoing basis. These are tested at the state-appointed laboratory at the University of the Free State. The results indicate that we have, more or less, halved the abuse of oil by frying establishments since in 1994.⁸

The most recent survey showed that 15% of the samples did not meet regulatory requirements (30% in 1995). 'The problem clearly remains serious and our efforts have not stopped all malpractices,' notes Kock. 'In April 2003, we analysed a sample that contained breakdown polymer levels of 58% when the regulatory level is 16%!' (The highest PTG level to be measured in the formal sector of the South Africa frying business was 75%.)⁸

SAFOI's most recent initiative is the introduction of a 'Seal of Approval' to be displayed on stable cooking oils that pass rigorous tests at the university. These measure the oil's response to regular frying conditions and its inherent oxidative stability. The objective of the endorsement is to provide buyers with an informed choice when selecting cooking oil.⁸

All South African oil manufacturers and distributors have been invited to submit their oils for testing and approval. The "Seal of Approval" will extend from wholesale ranges to household brands, and that South African consumers will benefit from greater awareness and the authenticity and quality of approved oils.⁷

2.9 **RAPID ‘ ON THE SPOT’ QUALITY ASSESSMENT OF FRYING FATS AND OILS**

Various rapid tests have developed under different names (Oxifrit Test, Col Test Fritest, Veri-Fry Colorimetric Test). These are of the colorimetric type, they use reactions with different bases, and their mechanism is complex and not fully established.¹⁷

It is obviously useful to have simple and quick tests, which can be applied without the frying operators needing much knowledge or training in analysis. The use of these tests also entails significant risks resulting precisely from the lack of knowledge and analytical understanding on the part of the staff that will be carrying out the test at the fryer in the kitchen. For this reason incorrect use is a risk to be assumed, but must be controlled as much as possible. Critical factors that must be controlled are the frequency of performance of the tests, appropriate storage of reagents and recording and assessing variation in behaviour of the tests, because in general they demonstrate relatively low accuracy and precision. However what is most important is to achieve some correlation with overall degradation measurements. It is important to from time to time to compare tests in the laboratory with other assessment parameters. The use of these tests is a tool that should be used much more intensively in frying establishments.¹⁷

Tests sensitive to carbonyls and oxidized products correlate well with each other, but their correlation with the percentage polar compounds or dielectric constant measurement are relatively good and depend very largely on the type of oil and the original food. On the other hand, they correlate rather poorly with alkaline material tests (soaps).¹⁷

2.9.1 **The Oxifrit Test (Oxidised Compound test)**

These use redox indicators, which react proportionally to the concentration of total oxidized compounds.¹⁷

Frying fats and oils deteriorate rapidly in the presence of atmospheric oxygen, moisture and the high frying temperatures which causes physical and chemical changes to take place in the frying medium resulting in the formation of numerous and complex oxidation products which are collectively referred to as oxidised fatty acids.¹³

The Oxifrit Test is a colour indicator test for the determination of oxidised fatty acids. After the test solution is added to the frying medium in a test tube and the mixture shaken, the colour changes to blue, green or olive depending upon the amount of oxidised fatty acids present in the frying oil.¹³

The results for this test are as follows: -

- | | |
|--------------|--|
| BLUE COLOUR | - the oil is fresh and unused. (Good) |
| GREEN COLOUR | - recommend the oil need to be changed. (Replace) |
| OLIVE COLOUR | - the oil is extremely deteriorated, unfit for further use and must definitely be discarded. ¹³ |

The sensitivity and specificity of the Oxifrit Test is not known.

2.9.2 Col Test

The Col Test is a colour indicator test to determine quality of the oil. The standard colours are labeled numerically. When the colour of the test (frying oil) sample is compared against the corresponding colour of the standard sample obtained, the resulting number will determine the quality of the oil and whether the frying oil can be used further or discarded.¹³

The standard colours have the following classification.

COLOUR 1 - The quality of the frying oil is good and can be used further.

COLOUR 2 - The quality of the oil is still acceptable as long as the taste of the fried food is acceptable.

COLOUR 3 - The frying oil has deteriorated and recommended to be changed.

COLOUR 4 - The frying oil is extremely deteriorated and unfit for further use.¹¹

(Annexure 4)

The sensitivity and the specificity of the Col Test is not known.

2.9.3 The Veri-Fry Colorimeter Test

The Veri-Fry Colorimeter Test is a simple and rapid test, which determines the Total Polar materials present in the hot frying medium when the frying oil is mixed with a blue gel in a test tube and shaken to dissolve the blue gel and then placed in the colorimeter.¹³

The reading from the colorimeter is the '**action number**'. This reading will determine whether the frying oil should be used further or should be discarded, depending on the '**action number**' readings determined beforehand against a series of standards of known concentrations of Total Polar Materials for frying oils and fats established by the frying establishment ¹¹.

2.9.4 **Carbonyl Compound Tests**

The main reagent of the test is a substance, which is capable of reacting more or less specifically to aldehydes and ketones.¹⁷

2.9.5 **Free Acidity tests**

These use base acid indicators which change colour depending on the pH.¹⁷

2.9.6 **Alkaline Soap Test**

This method is based on the fact that the fatty acids released in oils during frying react partially with food salts, give rise to alkaline soaps. Thus, although it is a less sensitive measurement, because the soaps accumulate in smaller quantities than the free acids.¹⁷

2.10 **BIOLOGICAL EFFECTS OF DETERIORATED FRYING FATS AND OILS**

It is commonly believed that fats subjected to high frying temperatures are dangerous to health.¹³

Poor communities in South Africa regularly ingest highly oxidized abused fats also known as super-oxidized soups. These increase the level of oxidized lipids in human plasma and may result in addition stress on endogenous anti-oxidative agents, which in turn can reduce the immune system ability to fight viral attack.¹⁹

A study conducted by the Shanghai Cancer Institute showed an association between lung cancer and measures of exposure to cooking oil vapours. The risk increased with the number of meals cooked by stir-frying or deep frying.¹⁹

Another similar study also showed that the number of deep fried meals consumed and the incidence of smokiness during cooking were associated with a higher than normal risk of lung cancer.¹⁹

Fats and oils differ from each other in their fatty acids, mostly in the degree of unsaturations. Also of importance is the presence of certain minor component, among which the most interesting are the antioxidants.¹³

A high degree of unsaturation makes fats more fluid, giving them also important biological properties, but, at the same time, making them more vulnerable to attack by atmospheric oxygen especially at high temperatures.¹³

The degradation products are peroxides, aldehydes, ketones, hydroperoxides, polymers and cyclic monomers. Each of these compounds can cause toxic effects. Even though aldehydes and ketones, being volatile, are easily eliminated and the polymers are little absorbed, there are numerous experimental studies, which may be relevant to man.¹³

Many compounds are formed during frying, but, from a toxicological point of view, most interest is directed at the formation of peroxides. Antioxidants can reduce the thermo-oxidative deterioration, but it must be pointed out that the same heating reduces the antioxidant content, particularly the tocopherols.¹³

2.10.1 The Absorption of Compounds from Used Frying Fats and Oils

The study of intestinal absorption of compounds derived from the heating of fats and oils is of fundamental importance for evaluating their biological effects. Volatile substances, though important indicators of quality variation are lost and have no biological interest.¹³

Studies conducted on non-volatile substances, with the cannulization of the lymphatic duct, have shown that oxidised monomers are well absorbed, while the absorption of cyclic monomers is very high but polymers are very poorly absorbed. This observation is of very great clinical relevance because cyclic monomers are considered responsible for toxic effects and their formation seems to be proportional to the degree of unsaturation of the fat, as well as, to the time of exposure to high temperatures.¹³

2.10.2 The Effects of Compounds from Used Frying Fats and Oils on Vitamins

Research has shown that frying, even for short periods, reduces the content of vitamin E. The harmful substances produced during the oxidation of the frying fats or oils especially cause the degradation of vitamin E in the intestine. The destruction of vitamin E in membranes by peroxides or the subsequent free radical reaction is more important and rather serious.¹³

2.10.3 The Effects of Compounds from Used Frying Fats and Oils on Body Weight and Growth Rate

The poor intestinal absorption of polymers and of heated fats and oils, in general, and the toxic effects caused by the degradation products are factors that result in loss of body weight and retard growth. Researchers conducted experiments on animals such as rabbits and rats and found that the ingestion of unused olive oil had no effect on body weight and growth rate, whereas the heated olive oil had a slight effect on body weight and growth rate.¹³

However, the ingestion of non-polar fractions from heated sunflower oil resulted in a reduction in the growth rate, while the ingestion of peroxidised and polymerized fractions of soybean oil showed a significant decrease in the growth rates as compared with the ingestion of fresh soybean oil.¹¹

2.10.4 The Effects of Compounds from Used Frying Fats and Oils on Stomach and Intestine

Researchers have found that cooked fats and oils can cause stomach and intestinal problems which could lead to carcinoma, diarrhoea and the disturbance of the absorption of essential vitamins, proteins and carbohydrates.¹³

2.10.5 The effects of Compounds from used Frying Fats and Oils on the Kidney

The ingestion of thermo-oxidised fats and oils caused the kidney to increase in volume. This resulted in cellular degeneration, tubular necrosis and granular clumps that blocked the tubular lumen. Such lesions seemed more severe with grape seed oil, sunflower oil and lard than with olive oil in which case the damage observed was limited to an activation of the tubular epithelial cell nuclei. These effects, though very slight, were noted also with lightly re-heated frying oils.¹³

2.10.6 The effects of Compounds from Used Frying Fats and Oils on the Liver

Studies have shown that, after heating, the more highly unsaturated fats and oils were responsible for greater liver damage than fats and oils of lesser unsaturation. This was confirmed when guinea pigs were fed with olive oil, sunflower oil, butter and lard, after being heated at 170°C and aerated for one hour, resulted in the appearance of severe fatty livers with granulomatous areas and hyperplasia of Kupffer cells. All the fats under examination had this effect except for olive oil, which caused only slight fatty degeneration.¹³

Researchers conducted experiments on rats by feeding them with olive oil, grape seed oil, cord oil and lard, both unused and heated for 72 hours at 180°C. The results showed that with olive oil there were no necrotic zones but only a severe pyknosis of the nucleus with cytoplasmic atrophy, whereas, with thermo-oxidised grape seed oil and lard there were areas of necrosis and granulation with invasion by histocytes.¹³

The liver reacts very differently in the case of fats cooked for a few hours, even at high temperatures, than it does when fats are cooked for a prolonged period. Researchers, having fed rats with fresh and heated sunflower oil and with polar and non-polar fractions of the used frying oil, observed a significant increase in liver weight with the polar fractions.¹³

This was expected, considering the fact that the polar fraction contains the highest concentration of oxidation products. The polar fraction affected a significant increase in serum glutamic-oxidoacetic and glutamic-pyruvic transaminase.¹³

Researchers studied the effect of cyclic dimers, trimers and monomers which were obtained from foods fried in soybean oil for 12 hours at 275°C under inert gas and noted modifications in hepatic lipids and an increase in serum alkaline phosphatase.¹³

2.10.7 The effects of Compounds from used Frying Fats and Oils on the Cardiovascular System

Studies have demonstrated that ingestion of cooked fats increased the level of plasma cholesterol and of beta-lipoproteins. This effect seemed to be more evident with the

use of animal fats, but it was also seen with sunflower oil, which also caused a significant increase in the beta-lipoproteins.¹³

Studies have shown that a massive calcification of the aorta's tunica media and sometimes even of the intima was due to the presence of polymers even though the fats contained sufficient essential fatty acids and vitamins and that these fats were not exposed to excessive heating.¹³

It seems that fats and oils that have been heated, especially for long periods, seem to exert an atherogenic effect which appear more marked with the more highly unsaturated oils than with saturated fats. The modifications undergone by fatty materials with frying can, in some conditions, be responsible for physiological changes, which can sometimes be severe.¹³

The more notable effects are exerted by degradation products, namely the peroxides, hydroperoxides, the cyclic polymers and monomers derived mainly from the polyunsaturated fatty acids, linoleic and linoleic acids. The presence of antioxidant agents can offer some protection, but because the oils and fats undergo extremely high temperatures there is also a decrease of the antioxidant levels due to the high frying temperatures.¹³

In order to reduce the abovementioned detrimental health effects and to prolong the useful life of frying oil, regular cleaning and maintenance of equipment, good quality frying oil and utilization of proper frying conditions are essential.²⁰

2.11 SUMMARY

The prevalence of abused cooking oil in South Africa is a matter of concern and the consequences of consumption of abused oil is associated with detrimental health effects. The literature review really provides a strong rationale for the need to monitor the quality of the oil.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The research methodology for the study is discussed in this chapter. The methodology comprises the sampling technique, the data collection procedure and the statistical analysis utilized for evaluating the checklist and the questionnaire responses.

3.2 STUDY DESIGN

An observational cross-sectional study design was used with both a descriptive and an analytical component. The descriptive component of the study helped towards the achievement of objectives 1-3, viz. establishing:

- The overall prevalence of the use of abused deep fried chip cooking oil at fast food outlets in the South Central Operational Entity;
- The supervision areas in the South Central Operational Entity where the use of abused oil is most prevalent;
- The reported practices in preserving the quality of chip oil.

The analytical component of the study helped towards the achievement of objective 4, viz:

- Making appropriate recommendations to owners/managers of the fast food outlets, and to EHPs.

3.3 STUDY PERIOD

The duration for completion of the study was one year, from planning the study to final write up. The data collection phase, with regards to the collection of samples of used deep fried chip cooking oil and the administering of the questionnaire on oil preservation practices, took place within a period of 3 weeks, starting from 14 August 2006 to 01 September 2006.

3.4 STUDY POPULATION

All fast food outlets making deep fried chips in the South Central Operational Entity registered with the eThekweni Health Department at the time of the study were included in the study population. There are approximately 800 fast food outlets

registered with the eThekweni Health Department in the South Central Operational Entity. All owners/managers of the fast food outlets preparing deep fried chips were included in the study. Restaurants were excluded from the study.

3.5 SAMPLING STRATEGY AND SAMPLING SIZE

3.5.1 Brief description of Lot Quality Assurance Sampling (LQAS)

LQAS is a rapid epidemiological assessment (REA) sampling method, suitable for small area surveys, usually conducted in an area served by an individual health worker a health service, or a health authority²⁰. The resources required to conduct a REA are fewer than those required for a large scale survey, and the results usually become available more promptly, thus contributing to timely decision-making at the local level.²¹

LQAS has its origin in industrial quality control where a certain number of items in a lot or batch are tested. On the basis of a number of defective items, the whole batch is judged as being defective or acceptable. Since testing is costly one would like to test as few items as possible.²¹ Several characteristics have made LQAS attractive to health system evaluators. Only a small sample is needed to judge whether a supervision area has reached the predetermined service target. With a small sample, data collection does not seriously compete with time for provision of health services. LQAS procedures and analysis are relatively simple. This simplicity is welcomed by overworked supervisors and health workers, who need management tools that can easily be understood and applied.²¹

The purpose of using LQAS is (i) to determine whether a specific supervision area has reached the predetermined service target; and (ii) to compare the performance of different supervision areas.²¹

In implementing LQAS health service managers need to identify two thresholds. The upper threshold is the service target (e.g. 80%), to be achieved in a determined time frame. The lower threshold is an unacceptably low level of service provision that should provoke managers to identify the problem causing the failed service delivery and to develop plans to resolve it with a focused investment of time and resources. It may be useful to think of the LQAS method as a triage system in

which: (i) successful supervision areas at or above the upper threshold are identified so it is known that they are not the source of programmatic problems, and (ii) supervision areas at or below the lower threshold are identified as priorities because they have unacceptably low service delivery. The middle area of the triage system – between the upper and lower thresholds – is an indeterminate zone. In practice, supervision areas with achievements closer to the upper threshold are more likely to be classified as reaching the target, while supervision areas with achievements closer to the lower threshold are likely to be prioritized as substandard. In either instance, the error is not serious. If a supervision area is slightly below the upper threshold and judged as having reached it, this error is not pernicious since it is more important for the health system to focus on supervision areas where a problem exists. Correspondingly, if a supervision area is slightly above the lower threshold and judged as well below the target, this also is not a worrisome error since the supervision area has not reached the coverage target and would have to be dealt with sooner or later.²²

3.5.2 Application of LQAS in this Study

The researcher is the EHP responsible for supervising all food outlets in the South Central Operational Entity. As mentioned in the introduction, the South Central Operational Entity is divided into 6 supervisory areas. Through the study the researcher tried to establish the overall prevalence of abused deep fried chip cooking oil, but for programmatic purposes, also to establish the supervision areas, which need to be targeted in order to deal with a problem more effectively. A small sample of outlets was selected from each supervision area to determine which supervision areas reached the service target (upper threshold) and which fell below the lower threshold. The list of all registered fast food outlets in the South Central Operational Entity was available in a database and this database was used as the sampling frame. A simple random sample of 19 fast food outlets in supervision areas one to five was selected. Outlets were randomly selected from the sampling frame by picking 19 random numbers from a hat per area. Supervision Area 6 is a small area and only has five registered outlets in it. All five were included in the study. A total of 100 outlets were included in the study. The sample of 19 provides an acceptable level of error for making management decisions. At least 92% of the time identifies whether a benchmark has been reached or whether an area is substantially below the average

performance of a programme. Samples larger than 19 per Supervision Area have practically the same statistical precision as 19. They do not result in better information and they cost more.²¹

With regards to service targets, a number of indicators were used to determine quality of the deep fried chip cooking oil. Counts that fall below the decision rule can be identified as in need of intervention. Supervision Area with the most number of counts falling below the decision rule will be prioritised.

3.7 VARIABLES TO BE MEASURED

3.7.1 Quality of the oil

The quality of the oil was determined using the Oxifrit Test, the Col Test, Particles Count Test, smell of oil, and the condition of fryer. The Oxifrit Test is a chemical indicator test that determines the quality of oil as either being good, bad or in need of replacement. Good oil is indicated by blue colouration. This means that the oil is still fresh. Bad oil is indicated by olive colouration, meaning that the oil is abused, whereas green colouration indicates that a change of oil is recommended.

The Col Test is a sensory test used for determining the degree of deterioration of the oil used in frying establishments (Annexure 4). This was an “on- the- spot” colour indicator test. The sample of the used oil is compared with Col Test indicator chart (Annexure 4).

The Particle Count Test required the data collector to observe the oil and determine whether the oil contained more than or less than 30 particle. The oil was divided into two categories, namely the acceptable category, having less than 30 particles and the unacceptable category, having more than 30 particles.

The smell of oil was also a sensory test, based on whether the oil had a fresh smell or rancid smell.

Lastly condition of fryer was observed either caked or good.

3.7.2 Reported Oil Preservation Practices

The following preservation practices were measured:

- (i) How often the oil was changed;
- (ii) How often the used oil was strained/filtered;
- (iii) How the oil was stored at the end of the day;
- (iv) Means of disposal for old oil;
- (v) The methods used for checking the quality of the oil.

3.8 **DATA COLLECTION METHODS AND INSTRUMENTS**

Table 1 summarizes the data collection method and instrument for each set of variables measured in the study.

Table 1: Summary of data collection methods and instruments.

Variable	Methods	Instruments
For checking the quality of the oil	Observation	Oxifrit test COL Test Particle Count Test Smell test
For checking the condition of the fryer	Observation	Observation checklist
For checking the amount of oil and potatoes purchased the previous month.	Interview	Closed-ended questionnaire
For determining oil preservation practices	Interview	Closed-ended questionnaire
For determining oil checking practices	Interview	Closed-ended questionnaire

3.8.1 For checking the Quality of Oil

(i) Oxifrit Test Procedure

100ml sterile bottles fitted with a sterile black screw-on cap were used to collect the oil samples, which were supplied by eThekwin Municipality Laboratory.

Identifiable water resistant labels were affixed to each sample bottle. The following information was transcribed thereon utilizing a permanent pen prior to the sample being taken:

- a) Sampling Code of the outlet (a code was used rather than the name of the outlet in order to ensure anonymity and confidentiality).
- b) Date and time of sample.
- c) Reference Code of Environmental Health Practitioner responsible for sampling.

The sampling form was also filled in bearing the sample code, date and Environmental Health Practitioner reference code (Annexure 05).

An 80 ml sample was taken directly from the chip deep fryer using a sterile metal ladle to pour used oil into bottle at each fast food outlet.

Samples were kept in a cooler box for safe transportation to the laboratory. Temperature not need to be considered as chemical testing only was done on the samples.

The Medical Technologist who was responsible for the chemical testing received the samples, together with their respective sampling forms. The laboratory was blinded. Samples were not assessed in batches or according to supervision areas. They were brought in randomly from different supervision areas.

The actual Chemical Test procedure for Oxifrit Test was as follows:

- (a) The syringe marked “test solution” was placed on the sampling adapter of the bottle containing reagent one.
- (b) The bottle containing the reagent was inverted and the syringe was filled to the mark with the test solution.
- (c) The process was repeated if air bubbles were included in the solution since such bubbles can affect the volume of solution in syringe.
- (d) Once the syringe was full, the contents was poured into one of the test tubes, 5 drops of reagent 2 was then added to the solution in the test tube and shaken gently.
- (e) Thereafter the sample oil was heated in a metal beaker to 180°C. The little scoop in the Oxifrit Kit was used to scoop the hot oil. The scoop was then emptied into the test tube with the reagent solution.

- (f) Thereafter the test tube was closed with a stopper and shaken vigorously for 5 seconds.
- (g) After 2 minutes the test tube was held between the coloured discs on the colour scale and the colour compared against a light background.²²

(ii) Col Test

This was an on-the-spot check, which was carried out once the sample had been taken at the fast food outlet. The oil sample was compared to the colour indicator chart (Annexure 4.)

(iii) Particle Count Test

This was done by visually observing and estimating the amount of particles in the fryer. Oil containing more than 30 particles was categorized as unacceptable whereas that containing less than 30 particles was categorized as being acceptable.

(iv) Smell Test

This was done by the EHP physically smelling the oil sample taken from the fryer. The oil was regarded either as being good or rancid.

3.8.2 For Checking the condition of the Fryer

This was done by the EHP physically observing the condition of the fryer. The condition of the fryer was either good or caked. The instrument used was an observational checklist. (Annexure 06)

3.8.3 For checking the amount of oil and potatoes purchased in the past month

The amount of oil and potatoes purchased in the past month were determined by the EHPs interviewing the owner/manager with a closed-ended questionnaire. Probing was used by EHPs to ensure a more truthful response.

3.8.4 For determining oil preservation practices

The Environmental Health Practitioners determined oil preservation practices by interviewing the owner/manager with a closed ended questionnaire. (Annexure 7) Probing was used by EHP's to ensure a more truthful response.

3.8.5 For determining oil checking practices

These were determined by the EHPs who interviewed the owner/manager of the fast food outlet with a closed ended questionnaire.

3.9 **METHODS TO ENSURE QUALITY OF DATA**

Data is only as good as the measurement instruments used to measure the characteristics. Ideally, we would like to measure “the truth” every time we measure the characteristics. Any deviation from this constitutes measurement error. Measures are usually considered in terms of reliability and validity. Reliability refers to the degree of similarity of the information obtained when the measurement is repeated on the same subject. Validity refers to the extent to which a measure actually measures what it is meant to measure.²¹

Reliability and validity in the study were ensured through the following:

3.9.1 Reliability of Oxifrit Test

The reliability of the Oxifrit test was ensured during the pilot study by taking duplicate samples. The one oil sample was sent to the laboratory in Pietermaritzburg and the other oil sample was sent to the eThekweni Food Safety Laboratory. A check was done to ensure both laboratories obtained the same results on the same oil sample.

3.9.2 Pilot Study

Validity was established by conducting a pilot study in the North Central Operational Entity and extracting comments on the relevance, balance and adequacy of the questionnaire and checklist in relation to the research objectives. This contributes to an improved questionnaire and checklist design. The pilot study also contributed to finalizing the logistics and field worker training.

3.9.3 Training of field workers

EHPs in the employment of the eThekweni Municipality were used as field workers. All field workers were trained, so that everyone knew exactly what was expected of them. During the training the nature of the research, the purpose of the research, and the objectives of the study were carefully explained before the field tasks were discussed in detail.

3.9.4 Field Supervision

During the data collection, the below mentioned field supervision tasks were conducted by the researcher. This ensured that accurate, reliable and quality data was received.

- (a) Checking of forms, ensuring that forms were filled in correctly and there was no missing information.
- (b) Ensuring that collection of data was done timeously by EHPs.
- (c) Ensuring that data was received promptly.
- (d) Assisting EHPs in the district if he/she was having any difficulties.

3.9.5 Translation

The field workers were both English and Zulu speaking. If the owner/manager of fast food outlet was not fluent in English the EHPs were in a position to communicate in Zulu.

3.9.6 Data Management

Before the analysis was done, the data set was carefully checked to identify outlying values. Outliers can strongly influence and bias the results thus it was important to detect and correct the data before it was processed and analysed. The checklist and questionnaires were checked for completion and quality during the data collection phase so that queries could be sorted out as soon as possible. Errors could also occur when the data was entered into the computer. The SPSS software package was used for data capture and analysis. Double entry of data was done whereby 2 data typists punched in the data independently and the two sets of data compared for discrepancies. Where errors were picked up, the researcher checked the raw data. Checklists and questionnaires were filed so that it was easy to verify forms with queries.

3.9.7 Coding/Re-coding of variables

Some variables from the closed-ended questionnaire were recoded into binary/dichotomous variables to facilitate statistical analysis. Table 2 illustrates how the variables were grouped.

Table 2. Coding/Re-coding of variables.

Variable	Recoded as acceptable when:	Recoded as unacceptable when:
Oxifrit Test result.	Good.	Bad. Replace.
Col Test result.	Good and still good.	Borderline. Replace.
Particle Count Test.	Less than 10, More than 10 but less than 30.	More than 30 but less 40, More than 40.
Age of oil.	1 to 3 days.	3 to 5 days, 5 to 7 days, More than 7 days.
Frequency of straining/filtering.	More than once a day, Once a day.	Every 2 to 3 days, Every 4 to 5 days, Not at all.
Disposal of used oil.	Taken by private company or DSW.	Pour down the drain, Given to staff, Sold to staff.
Storage of oil.	Emptied and kept in fridge, Emptied and kept in container.	Still kept in fryer.

3.10 DATA ANALYSIS

3.10.1 Descriptive Component

3.10.1.1 Frequency distribution were used to:

- (a) Calculate the overall prevalence of abused cooking and good cooking oil in the South Central Operational Entity.
- (b) Identify the supervision areas falling above the upper threshold and those falling below the lower threshold.
- (c) Summarize the reported oil preservation practices.
- (d) Summarize the reported oil checking practices.
- (e) Establish the quantity of oil and potatoes purchased in past month.

3.10.1.2 Measures of central location and variability.

The checklist and questionnaire were given a numerical score (Annexure 8 and 9). The numerical score rating were based on cooking oil quality practices. Acceptable cooking oil practices were rated a higher score as compared to unacceptable practices. The data collectors and managers / owners of the fast food outlets were blinded with regards to the score allocation per observation and question. The total score of the checklist and questionnaire per fast food outlet was used to calculate the mean and median percentage scores, as well as the range, standard deviations and interquartile ranges.

3.10.2 Analytical Component

In order to achieve Study Objective 4, and make evidence-based recommendations, the following analyses were performed:

- The sensitivity and specificity of the non-chemical methods for assessing the quality of the oil, in relation to the Oxifrit test, were determined.
- The association was measured between the Oxifrit result and;
 - The condition of the fryer.
 - Oil to potato ratio.
 - Each of the reported oil preservation practices.
 - Each of the reported oil checking practices.
- Multivariate logistic regressions were performed in order to establish the factors that are associated with poor quality oil as per Oxifrit test.

3.11 OVERCOMING BIAS

- (a) Selection bias was reduced by using simple random sampling to select the sample of 19 from within each sampling area. All fast food outlets making deep fried chips in the South Central Operational Entity were included in the study population.
- (b) Interviewer bias was reduced by extensively training the Environmental Health Practitioners responsible for data collection two weeks prior to the sampling. EHP's were briefed in detail about the study design, purpose, its objectives and how to carry out the actual data collection. The oil sampling procedure checklists as well as the administration of the questionnaire were discussed in detail. All concerns and doubts among EHPs were also clarified during the training sessions. Regular and intensive field supervision was carried out (see 3.9.4).
- (c) Recall bias was reduced by looking at current cooking preservation practices. There was no need for participants to think back in time.
- (d) Information bias was reduced by the questionnaire being anonymous so as to ensure confidentiality.
- (e) Measurement bias was reduced by the cooking oil sample tests being carried out by a qualified Medical Technologist as well as by ensuring the reliability of the test by corroborating the results from the eThekweni Food Safety Laboratory and the Pietermaritzburg Laboratory. Possible confounders are the time of day and time in the week that the samples were collected. This relates to the fact that the oil may be of better quality on Monday and in the mornings. In fact fast food outlets change their oil on any day of the week and at any time. This had been confirmed by EHP consultation. Confounding was also overcome by the fact that samples were randomly taken from Monday till Friday at different times in the day.
- (f) Misclassification bias: The test method is very simple; no need for equipment to be calibrated and the final result is compared to a distinct colour indicator chart. However, there may have been misclassification since the sensitivity and specificity of the Oxifrit Test is not known.

3.12 **ETHICAL CONSIDERATION**

Ethical approval was obtained from University of KwaZulu-Natal Research Ethics Committee for carrying out the abovementioned research (ref. EXP004/06 Annexure 10).

Written permission (Annexure 11) to conduct the study was obtained from the Food Safety Department of the eThekweni Municipality as well as permission for:

- (a) Allowing Senior EHPs to be involved in the study data collection;
- (b) The use of the Food Safety Laboratory resources for the analysis of the oil samples.

Informed written consent was obtained from the owner/manager of the fast food outlet (Annexure 12) The owner/manager of the fast food outlet was provided with all the relevant facts needed to make a decision about participation in the study (Annexure 13), which included the:

- (a) Purpose of study;
- (b) Data collection process;
- (c) The potential risks for the owner/manager.

Confidentiality was enforced by the fact that checklists and questionnaires did not bear the participants name, surname, or identity number, as the checklist and questionnaires were given a reference number for identification purposes. Data entered into the computer system was coded so as to ensure confidentiality of participants.

The owner/manager was informed that participation was voluntary and he/she could withdraw at any stage with no negative repercussions. All information obtained from the owner/manager from the fast food outlet was confidential.

With regards to the principle of beneficence for all, and without breaching confidentiality by targeting the poorer performing outlets, all managers/owners were educated about the effects of abused cooking oil on health. An information brochure on the preservation of the quality of frying oil was discussed and left with the owner/manager of the premises at the end of the data collection (Annexure 14).

Furthermore, the benefit of the research is that it provides the EHP of the South Central Operational Entity of the eThekweni Municipality with information which supervision areas fall below the lower threshold. This enables the EHP to target these areas with regards to monitoring, educating and regulating the use of abused cooking oils in these supervisory areas. The study also indirectly benefits the consumers of fast food.

3.13 LIMITATIONS

3.13.1 Limitations that could not be avoided

- (a) Due to limited resources the study was only based on fast food outlets in the South Central Operational Entity.
- (b) One of the assumptions was that all fast food outlets are using equivalent quality raw oil. To test the quality of raw oil involves analysis of its molecular compounds. This is an extremely expensive laboratory analysis, which was beyond the financial resources available for this study.
- (c) More valid results would have been obtained if multiple collections of oil samples were taken at the same facility over time so as to provide a more accurate picture of the quality of the oil. However due to limited financial resources multiple sampling was not possible.
- (d) Only outlets registered were sampled. Informal outlets were not included in the study.
- (e) Sensitivity and specificity of Oxifrit Test is not known.
- (f) The amount of particles in the fryer was only estimated due to time constraints. The filtration process would have taken too long.

3.13.2 Limitations picked up after data collection

During data collection it was found that some chip fryers were not in use, either because the fast food outlets were not busy or because chips had already been fried and the fryers were switched off, thus the temperature of oil was very low or cold. This measure was thus excluded from the analysis.

3.14 SUMMARY

An observational study with a descriptive and an analytical component was implemented, utilizing LQAS, in fast food outlets in the South Central Operational entity of the eThekweni Municipality. A total of 100 outlets were sampled, with 19 outlets per supervision area. The upper threshold of performance was set at 80%, and the lower threshold at 60%. The quality of the oil and oil preservation practices were determined.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

The study was designed to determine the quality of deep fried chip cooking oil at fast food outlets in the South Central Entity within eThekweni Municipality. The study determined the overall prevalence of the use of abused deep fried chip cooking oils at fast food outlets, and identified the areas where the problem was most prevalent via lot quality assurance sampling. The results were obtained using various methods described in Chapter 3. The results are organized according to the objectives, namely:

- (i) Prevalence of abused deep fried chip cooking oil, which includes the overall quality of the oil and the quality of the oil per supervision area. The quality of the oil is described according to the results for Oxifrit Test, Col Test, Particle Count Test and the smell of the oil.
- (ii) Oil preservation practices and these include:
 - Condition of the fryer;
 - Age of oil;
 - Oil to potato ratio
 - Reported oil preservation practices;
 - Reported oil checking practices.

The benchmark at the beginning of the study called for 80% of fast food outlets to report acceptable quality of oil. This meant that 13 out of 19 outlets sampled in each supervision area needed to comply with this benchmark. None of the outlets did reach this benchmark so the decision rule on whether to accept or reject a supervision area was based on the average obtained per characteristic measured. In Supervision Area 6 census was used thus the true average for this area can be calculated. For decision rules equivalent to each average please refer to Annexure 3.

4.2 PREVALENCE OF ABUSED DEEP FRIED CHIP COOKING OIL

The findings for the section are summarized in Table 3.

4.2.1 Oxifrit Test

The Oxifrit Test revealed that overall 60% of the outlets had oil that was acceptable whereas 40% had oil that was unacceptable (abused). The LQAS decision rule for the Oxifrit Test was 9. None of the Supervision Areas performed worse than the average for the district.

Table 3: Quality of the Oil (Observations)

			Oxifrit test categorised		COL test category		Particles in oil categorized		Smell of oil	
			Acceptable (good)	unacceptable (bad or replace)	Good	Borderline/ replace	Acceptable (<30)	Unacceptable (≥30)	Fresh	Rancid
Area code	1	Count (19)	12	7	14	5	11	8	18	1
	2	Count (19)	11	8	15	4	12	7	17	2
	3	Count (19)	12	7	16	3	15	4	16	3
	4	Count (19)	11	8	11	8	13	6	14	5
	5	Count (19)	11	8	11	8	6	13	18	1
	6	Count (5)	3	2	3	2	0	5	5	0
Total		Count	60	40	70	30	57	43	88	12
		% Within Area	60.0%	40.0%	70.0%	30.0%	57.0%	43.0%	88.0%	12.0%
		Decision Rule	9		11		9		15	

4.2.2 Col Test

The Col Test revealed that overall 70% of the oil results were acceptable. whereas 30% were unacceptable. The decision rule for the Col Test was 11. None of the Supervision Areas were below average.

4.2.3 Particle Count Test

Overall 57% of the fast food outlets sampled had an acceptable amount of particles in the oil. Supervision Area 5 was below average in this regard.

4.2.4 Smell of oil

Overall 88% of the oil samples smelt fresh. Supervision Area 4 was below average.

4.3 OIL PRESERVATION PRACTICES

4.3.1 Condition of the fryer

Overall 78% deep fryers were in a hygienic condition. Supervision Area 6 was below average.

Table 4: General Hygienic Condition of Fryer

			General hygienic condition		Total
			Good	Caked	
Area code	1	Count	17	2	19
	2	Count	17	2	19
	3	Count	16	3	19
	4	Count	14	5	19
	5	Count	14	5	19
	6	Count	0	5	5
Total		Count	78	22	100
		% Within Area	78%	22%	100%
		Decision Rule	13		

4.3.2 Reported characteristics of the oil

4.3.2.1 Type of Oil

All outlets (100%) used oil of the vegetable type.

4.3.2.2 Age of Oil

Overall 63% of the oil observed was reported to be less than 3 days old. Supervision Area 2 was below average on this score.

Table 5: Age of Oil

			Age of oil categorised		Total
			<3 days	>= 3 days	
Area code	1	Count	14	5	19
	2	Count	7	12	19
	3	Count	13	6	19
	4	Count	15	4	19
	5	Count	10	9	19
	6	Count	4	1	5
Total		Count	63	37	100
		% Within Area Code	63%	37%	100%
		Decision Rule	10		

4.3.3 Ratio of oil to potato

Data was obtained on the quantity of oil and potatoes purchased by each fast food outlet in the previous month. This was converted to oil to potato ratio. An acceptable oil to potato ratio was defined as 1litre oil to 1 kilogram potatoes, and a ratio where there was less than one litre of oil to one kilogram of potato was categorized as an acceptable ratio.

Overall 80% of the fast food outlets sampled had an acceptable ratio of oil to potato whereas 20% had an unacceptable ratio. The decision rule for the oil to potato ratio was 13, which was not met by only Supervision Area 4.

Table 6: Ratio of oil to Potato

			Oil/Potato Ratio		Total
			Acceptable Ratio (1:1)	Unacceptable Ratio (>1:1)	
Area code	1	Count	13	6	19
	2	Count	18	1	19
	3	Count	16	3	19
	4	Count	12	7	19
	5	Count	16	3	19
	6	Count	5	0	5
Total		Count	80	20	100
		% Within Area Code	80%	205	100%
		Decision Rule	13		

4.3.4 Reported oil preservation practices

The findings for the section are summarized in Table 7.

4.3.4.1 Frequency of Oil Change

36% of the fast food outlets reported that they changed the oil at least every 3 days (Table 7). Supervision Area 6 was below average in this regard.

Table 7: Reported Oil Preservation Practices

			How often is the oil changed		How often is the used oil strained/filtered category		How is oil stored at end of day		What means of disposal do you use for old oil?	
			<= 3 days	> 3 days	<= once a day	>= Every 2 nd day	Acceptable (emptied and kept in fridge / emptied and kept in container at ambient temp)	Unacceptable (still kept in fryer)	Taken by reputable company (taken by private company / DSW)	Not taken by reputable company (pour down drain, given to staff, sold to public)
Area code	1	Count (19)	10	9	8	11	7	12	10	9
	2	Count (19)	5	14	6	13	9	10	12	7
	3	Count (19)	8	11	5	14	2	17	17	2
	4	Count (19)	7	12	4	15	4	15	16	3
	5	Count (19)	6	13	15	4	9	10	19	0
	6	Count (5)	0	5	5	0	3	2	5	0
Total		Count	36	64	43	57	34	66	79	21
		% Within Area	36%	64%	43%	57%	34%	66%	79%	21%
		Decision Rule	5		6		4		13	

4.3.4.2 Frequency of Straining / Filtering the Oil in the Fryer

43% outlets filtered / strained the oil at least once a day or more frequently. Supervision Area 3 and 4 were below average in doing this.

4.3.4.3 Storage of Oil

34% of outlets stored the oil in an acceptable manner (emptied and kept in fridge or emptied and kept in container at ambient temperature). Supervision Areas 3 was below average in this regard.

4.3.4.4 Disposal of Oil

79% of fast food outlets had the old oil taken away by a reputable company (taken by private company / Durban Solid Waste). Supervision Areas 1 and 2 were below in average.

4.3.5 Reported oil checking practices

The findings for the section are summarized in Table 8. All the fast food outlets used at least one of the oil checking practices.

4.3.5.1 Chemical Testing

Overall 4% used chemical testing whereas the remaining 96% did not use the chemical testing method.

4.3.5.2 Colour Test

Overall 88% outlets used the colour testing method whereas the remaining 12% did not use the colour testing to determine when used oil needs to be discarded.

Table 8: Reported Oil Checking Practices

			Chemical testing		Colour testing		Smell test	
			Yes	No	Yes	No	Yes	No
Area code	1	Count	1	18	18	1	11	8
	2	Count	0	19	19	0	12	7
	3	Count	0	19	19	0	5	14
	4	Count	0	19	11	8	8	11
	5	Count	1	18	18	1	1	18
	6	Count	2	3	3	2	0	5
Total		Count	4	96	88	12	37	63
		%Within Area	4%	96%	88%	12%	37%	63%
		Decision Rule	Not applicable		15		5	

4.3.5.3 Smell Testing

Overall 37% outlets used smell testing whereas the remaining 63% did not use smell testing to determine when used oil needs to be discarded.

4.3.5.4 Taste Test

None of the premises used the taste testing method.

4.4 Summary of all Indicators used to assess the quality of deep fried cooking oil in South Central Operational Entity.

Table 9 shows a summary of all indicators used to assess the quality of deep fried cooking oil and oil preservation practices. It shows the count for each Supervision Area, the average for the whole South Central Operational Entity and those Supervision Areas that fall below average based on the decision rule. All counts underlined fell below the decision rule based on the average. Based on the number of indicators that fall below the average in each Supervision Area, Supervision Area 6 is most problematic and needs to be prioritised followed by Supervision Area 4.

Table 9: Summary of all Indicators used to assess the quality of deep fried cooking oil and oil preservation practices in the South Central Operational Entity.

		Oxifrit Test	Col Test	Particle count Test	Smell Test	Caking of Fryer	Age of oil	Oil: Potato Ratio (1:1)	Oil Changed (<3 days)	Strained/ Filtered (<=1day)	Stored (Acceptable Manner)	Disposal of oil (Acceptable Manner)	Colour Test Practice	Smell Test Practice	Total no of Items Below Average
	Supervision Area 1	12	14	11	18	17	14	13	10	8	7	<u>10</u>	18	11	1
	Supervision Area 2	11	15	12	17	17	<u>7</u>	18	5	6	9	<u>12</u>	19	12	2
	Supervision Area 3	12	16	15	16	16	13	16	8	<u>5</u>	<u>2</u>	17	19	5	2
	Supervision Area 4	11	11	13	<u>14</u>	14	15	<u>12</u>	7	<u>4</u>	4	16	<u>11</u>	8	3
	Supervision Area 5	11	11	<u>6</u>	18	14	10	16	6	15	9	19	18	<u>1</u>	1
	Supervision Area 6	3	<u>3</u>	<u>0</u>	5	<u>0</u>	4	5	<u>0</u>	5	3	5	<u>3</u>	<u>0</u>	6
	Average %	60%	70%	57%	88%	78%	63%	80%	36%	43%	34%	79%	88%	37%	
	Decision Rule	9	11	9	15	13	10	13	5	6	4	13	15	5	

Narative: All underlined counts fall below the Decision Rule based on the average.

Table 9: Summary of all Indicators used to assess the quality of deep fried cooking oil and oil preservation practices in the South Central Operational Entity.

		Oxifrit Test	Col Test	Particle count Test	Smell Test	Caking of Fryer	Age of oil	Oil: Potato Ratio (1:1)	Oil Changed (<3 days)	Strained/ Filtered (<=1day)	Stored (Acceptable Manner)	Disposal of oil (Acceptable Manner)	Colour Test Practice	Smell Test Practice	Total no of Items Below Average
	Supervision Area 1	12	14	11	18	17	14	13	10	8	7	<u>10</u>	18	11	1
	Supervision Area 2	11	15	12	17	17	<u>7</u>	18	5	6	9	<u>12</u>	19	12	2
	Supervision Area 3	12	16	15	16	16	13	16	8	<u>5</u>	<u>2</u>	17	19	5	2
	Supervision Area 4	11	11	13	<u>14</u>	14	15	<u>12</u>	7	<u>4</u>	4	16	<u>11</u>	8	3
	Supervision Area 5	11	11	<u>6</u>	18	14	10	16	6	15	9	19	18	<u>1</u>	1
	Supervision Area 6	3	<u>3</u>	<u>0</u>	5	<u>0</u>	4	5	<u>0</u>	5	3	5	<u>3</u>	<u>0</u>	6
	Average %	60%	70%	57%	88%	78%	63%	80%	36%	43%	34%	79%	88%	37%	
	Decision Rule	9	11	9	15	13	10	13	5	6	4	13	15	5	

Narative: All underlined counts fall below the Decision Rule based on the average.

4.5 SUMMARY STATISTICS: MEASURES OF CENTRAL LOCATION AND VARIABILITY

As stated in the methodology section, the observation checklist and questionnaire were allocated an overall numerical score, expressed as a percentage score. The distribution of this data was fairly symmetrical (see figure 1). The overall mean percentage score was 56% (CI 53% – 58%) The range was 26% to 90%, the standard deviation was 12%.

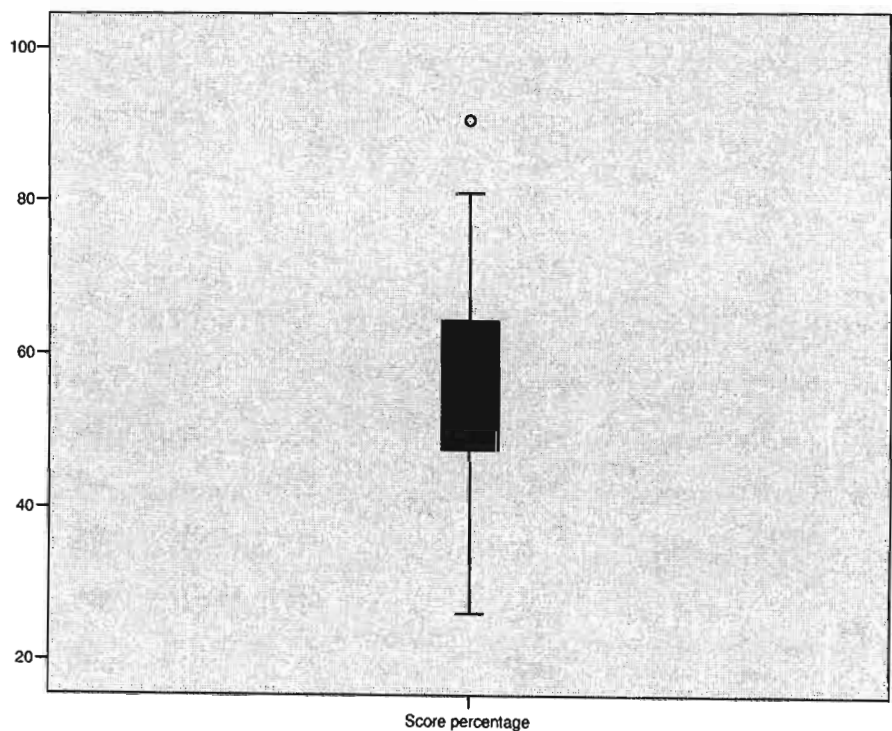


Figure 1: Box Plot of all Scores

Table 10: Summary statistics

Statistics Percentage Score		
N	Valid	100
	Missing	0
Mean		55.95
Confidence Interval		53.5% – 58.4%
Std. Deviation		12.31
Minimum		26.2
Maximum		90.5

Outlets with good Oxifrit test results were grouped, as were those with bad Oxifrit test results. Figure 2 shows the distribution of the data within these two groupings.

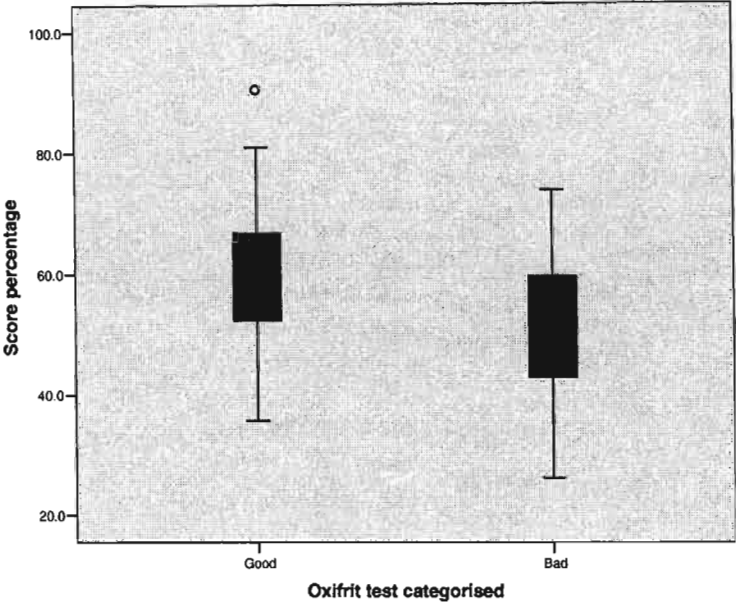


Figure 2: Showing Percentage Score Relationship to Oxifrit Test Results

The Oxifrit Test classified 60% of oil samples as being acceptable and 40% as being unacceptable. The mean percentage score for the outlets with acceptable oil results was 60% (SD = 10,5 and SE = 1,3) compared with the mean percentage score of 50% (SD = 12,3 and SE = 1,9) for the outlets that obtained unacceptable oil results (Table 11).

Table 11: Group Statistic for Oxifrit Test

Group Statistics					Independent Sample Test			
	Oxifrit test categorised	N	Mean	Std. Deviation			t	Sig (2 tailed)
Percentage Scores	Not acceptable (bad or replace)	40	49.8	12.3	Score percentage	Equal Variance Assumed	-4,34	.000
	Acceptable (good)	60	60.0	10.5				

Where equal variance was assumed, there was a significant difference in the mean percentage score of the outlets with acceptable oil results compared to those with unacceptable oil results. The mean percentage score in outlets with acceptable Oxifrit Test results was significantly higher than in outlets with unacceptable Oxifrit test results (mean difference -10,22 $p < 0,001$).

4.6 SENSITIVITY AND SPECIFICITY OF NON-CHEMICAL METHODS FOR ASSESSING THE QUALITY OF THE OIL

A very small proportion of outlets use chemical testing to assess the quality of their oil. This section reports on the association between the non chemical methods for assessing the quality of the oil and the Oxifrit Test i.e. how frequently do unacceptable test results obtained with the non chemical methods concur with unacceptable test results obtained with the Oxifrit Test. High sensitivity is sought to identify the truly bad oil.

4.6.1 Col test versus Oxifrit Test

Table 12: Col Test versus Oxifrit Test

Oxifrit Test			
	Unacceptable (bad / replace)	Acceptable (good)	TOTAL
Borderline / replace	30 (100%)	0 (0%)	30 (100%)
Col Test (good / still good)	10 (14.3%)	60 (85.7%)	70 (100%)
TOTAL	40 (40%)	60 (60%)	100 (100%)

The specificity of the Col Test is 100% (CI 93 – 100%).

The sensitivity of the Col Test is 75% (CI 58 – 93%).

The positive predictive value for the Col Test is 86% (CI 75 – 93%).

4.6.2 Particle Count Test versus Oxifrit Test

Table 13: Particles Count Test versus Oxifrit Test

Oxifrit Test				
		Unacceptable (bad / replace)	Acceptable (good)	TOTAL
Particles in oil	Unacceptable ≥ 30	27 (62.8%)	16 (37.2%)	43 (100%)
	Acceptable < 30	13 (22.8%)	44 (77.2%)	57 (100%)
	TOTAL	40 (40%)	60 (60%)	100 (100%)

The specificity of the particle count test is 73% (CI 60 – 84%).

The sensitivity of the particle count test is 68% (CI 51 – 81%).

The positive predictive value for the particle count test is 77% (CI 64 – 87%).

4.6.3 Smell Test versus Oxifrit Test

Table 14: Smell of Oil versus Oxifrit Test

		Oxifrit Test		
		Unacceptable (bad / replace)	Acceptable (good)	TOTAL
Smell of oil	Rancid	12 (100%)	0 (0%)	12 (12%)
	Fresh	28 (31.8%)	60 (68.2%)	88 (100%)
	TOTAL	40 (40%)	60 (60%)	100 (100%)

The specificity of the smell test is 100% (CI 93 – 100%).

The sensitivity of the smell test is 30% (CI 17 – 47%).

The positive predictive value for the smell test is 68% (CI 57 – 77%).

4.7 MEASURES OF ASSOCIATION

The association was measured between the Oxifrit Test and:

- The condition of the fryer
- Amount of oil to potatoes ratio
- Reported oil preservation practices
- Reported oil checking practices

The strength of the associations is reported as odds ratio, with p. values and 95% confidence intervals.

4.7.1 Association between Oxifrit Test and observed condition of fryer

Table 15: Condition of fryer versus Oxifrit Test

Oxifrit Test				
		Acceptable (Good)	Unacceptable (bad or replace)	TOTAL
General hygienic condition	Good	63 (71.6%)	25 (28.4%)	88 (100%)
	Caked	7 (31.8%)	15 (68.2%)	22 (100%)
	TOTAL	60 (60%)	40 (40%)	100 (100%)

In the presence of a caked fryer 68% of oil samples were unacceptable, compared to 28% that were in a good condition fryer. In the presence of a caked fryer, the Oxifrit Test is 5.4 times more likely to produce an unacceptable result on the quality of oil. This association is statistically significant. (OR 5.4, p value <0.001, CI 2.0 to 14.8).

4.7.2 Association between Oxifrit Test and Oil to Potato Ratio

The strength of association between the Oxifrit result and the oil to potato ratio was measured.

Table 16: Oil/Potato ratio versus Oxifrit Test

			Oxifrit test categorised		Total
			Acceptable (good)	Not acceptable (bad or replace)	
Oil/potato ratio category	Good	Count % Within Oil/potato ratio category	47 (58.8%)	33 (41.3%)	80 (100%)
	Bad	Count % Within Oil/potato ratio category	13 (65.0%)	7 (35.0%)	20 (100%)
TOTAL		Count % Within Oil/potato ratio category	60 (60.0%)	40 (40.0%)	100 (100%)

In the presence of a bad oil/potato ratio 35% of outlets had oil that was unacceptable. In the presence of a bad oil/potato ratio, the Oxifrit Test is 20% less likely likely to produce an unacceptable result on the quality of oil. This association is not statistically significant. (OR 0.8, p value = 0.8, CI 0.3 to 2.1).

4.7.3 Association between Oxifrit Test and Reported Oil Preservation Practices

4.7.3.1 Association between Oxifrit Test and frequency of oil change

Table 17: Frequency of Oil Change versus Oxifrit Test

		Oxifrit Test		
		Acceptable (Good)	Unacceptable (bad or replace)	TOTAL
How often oil changed	</=3 days	26 (72.2%)	10 (27.8%)	36 (100%)
	>3 days	34 (53.1%)	30 (46.9%)	64 (100%)
	TOTAL	60 (60%)	40 (40%)	100 (100%)

In the presence of oil changed more frequently than 3 days, 47% of outlets had oil samples that were unacceptable compared to the 37% where the oil was changed more frequently. In the presence of oil change in more than 3 days, the Oxifrit Test is 2.3 times more likely to produce an unacceptable result on the quality of oil. The association is of borderline significance. (OR 2.3, p value = 0.1, CI 1 to 5.6).

4.7.3.2 Association between Oxifrit test and frequency of straining/filtering oil

Table 18: Frequency of Straining / Filtering Oil versus Oxifrit Test

		Oxifrit Test		
		Acceptable (Good)	Unacceptable (bad or replace)	TOTAL
How often is used oil strained/ filtered	</= Once a day	27 (62.8%)	16 (37.2%)	43 (100%)
	>=Every 2 nd day	33 (57.9%)	24 (42.1%)	57 (100%)
	TOTAL	60 (60%)	40 (40%)	100 (100%)

Where the oil was strained/filtered every 2 days or more frequently, 42% of oil samples were unacceptable. Where the oil is strained/filtered every second day or less frequently, the Oxifrit Test is 13.5 times more likely to produce an unacceptable oil result. The association is not significant. (OR 1.22, p value = 0.6, CI 0.6 to 28).

4.7.3.3 Association between Oxifrit test and storage of oil at end of day

Table 19: Storage of Oil versus Oxifrit Test

		Oxifrit Test		
		Acceptable (Good)	Unacceptable (bad or replace)	TOTAL
How oil stored at end of day	Emptied and kept in fridge or container	23 (67.6%)	11 (32.4%)	34 (100%)
	Still in fryer	37 (56.1%)	29 (43.9%)	66 (100%)
	TOTAL	60 (60%)	40 (40%)	100 (100%)

In outlets where the oil was left in the fryer, 44% of oil samples were unacceptable. In the presence of oil stored in fryer, the Oxifrit Test is 1.6 times more likely to produce an unacceptable result on the quality of oil. The association is not statistically significant. (OR 1.6, p value = 0.8, CI 0.7 to 3.9).

4.7.3.4 Association between Oxifrit test and disposal of oil

Table 20: Disposal of Oil versus Oxifrit Test

			Oxifrit test categorised		Total
			Acceptable (good)	Not acceptable (bad or replace)	
Disposal	Taken by reputable company	Count % Within Disposal	48 (60.8%)	31 (39.2%)	79 (100%)
	Not taken by reputable company	Count % Within Disposal	12 (57.1%)	9 (42.9%)	21 (100%)
TOTAL		Count % Within Disposal	60 (60.0%)	40 (40.0%)	100 (100%)

In outlets where a reputable company did not take the oil, 43% of oil samples were unacceptable compared to 39% in outlets where a reputable company disposed the oil. Where the oil not taken by reputable company, the Oxifrit Test was 1.2 times more likely to produce an unacceptable result on the quality of oil. The association is not statistically significant. (OR 1.2, p value = 0.8, CI 0.4 to 3.1)

4.7.4 Association between Oxifrit test and reported oil checking practices

4.7.4.1 Association between Oxifrit test and chemical testing

Table 21: Chemical Testing versus Oxifrit Test

Oxifrit Test				
		Acceptable (Good)	Unacceptable (bad or replace)	TOTAL
Chemical testing	Yes	1 (25%)	3 (75%)	4 (100%)
	No	59 (61.5%)	37 (38.5%)	96 (100%)
	TOTAL	60 (60%)	40 (40%)	100 (100%)

In outlets where there was no chemical testing done, 39% of oil samples were unacceptable. In the presence of no chemical testing, Oxifrit Test is 4,78 times more likely to produce an unacceptable result on the quality of oil. The association is statistically not significant. (OR 4.78, p value = 0.35, CI 0.48 to 47.73).

4.7.4.2 Association between Oxifrit test and colour test

Table 22: Colour Test versus Oxifrit Test

Oxifrit Test				
		Acceptable (Good)	Unacceptable (bad or replace)	TOTAL
Colour test	Yes	51 (58%)	37 (42%)	88 (100%)
	No	9 (75%)	3 (25%)	12 (100%)
	TOTAL	60 (60%)	40 (40%)	100 (100%)

In outlets where there was no colour testing done, 25% of the oil samples were unacceptable. In the presence of no colour testing, the Oxifrit Test is 2,18 times more likely to produce an unacceptable result on the quality of oil. The association is statistically not significant. (OR 2.18, p value 0.41, CI 0.55 to 8.60).

4.7.4.3 Association between Oxifrit test and Smell test

Table 23: Smell Test versus Oxifrit Test

Oxifrit Test				
		Acceptable (Good)	Unacceptable (bad or replace)	TOTAL
Smell test	Yes	27 (73%)	10 (27%)	37 (100%)
	No	33 (52.4%)	30 (47.6%)	63 (100%)
	TOTAL	60 (60%)	40 (40%)	100 (100%)

If outlets reported that they did not do smell testing then 48% of oil samples were unacceptable. In the presence of smell testing 59% less likely to obtain an unacceptable Oxifrit Test. The association is statistically significant. (OR 0.41, p value =0.06, CI 0.17 to 0.98).

4.7.4.4 Association with Oxifrit test and Taste test

None of the fast food outlets used taste test thus no association could be measured between the Oxifrit test and Taste test.

4.8 FACTORS ASSOCIATED WITH POOR QUALITY OIL: MULTIPLE LOGISTIC REGRESSION

4.8.1 Multiple Logistic Regression

Table 24: Multiple Logistic Regressions

Variable	Sig	Odds Ratio	95% Confidence Interval	
			Lower	Upper
Hygienic condition of fryer (caked versus good)	.012	3.890	1.356	11.158
Frequency of oil change (≤ 3 days versus > 3 day)	.010	3.210	1.321	7.799
Constant	.000	.310	-	-

In the multivariate analysis, significant relationships were identified between an unacceptable Oxifrit result and the condition of the fryer, the frequency of oil change and the smell test.

When modeling these together the smell of the oil is not significantly associated to an unacceptable Oxifrit result. The only factors significantly associated with poor quality oil as per Oxifrit were condition of the fryer and frequency of oil change. Controlling for frequency of oil change, a caked fryer was 3.9 times more likely to produce an unacceptable Oxifrit Result (OR 3.9, p value = <0.001, CI = 1.4 to 11.1). Controlling for the condition of the fryer, if the oil was changed more than 3 days, then the Oxifrit result was 3.2 times more likely to be unacceptable (OR 3.2, P Value = 0.01 and CI 1.3 to 7.8).

4.9 SUMMARY

The overall prevalence of the use of abused cooking oil was 40%. With an 80% upper threshold the Decision Rule was 13 and no Supervision Area achieved this on the Oxifrit Test. The oil preservation practices significantly associated with the quality of the oil in this study are the condition of the fryer and the frequency of oil change.

CHAPTER 5

DISCUSSION

5.1 INTRODUCTION

In the previous chapter the results of the study were presented. In this chapter the results are discussed. The discussion will be presented according to each study objective with recommendations reported in chapter 6.

5.2 PREVALENCE OF ABUSED DEEP FRIED CHIP COOKING OIL

The overall prevalence of the use of abused deep fried chip cooking oils in fast food outlets in the South Central Operational Entity was 40%. These results are based on the Oxifrit Test, which was the benchmark in this study. An unacceptable result on the Oxifrit Test means that the oil samples had deteriorated by the time of sampling and were unfit for further use and should have been discarded.

This prevalence of abused cooking oil cannot be compared to results from previous studies in the South Central Operational Entity since this was the first time a study of such a nature was conducted in the eThekweni Municipality.

When compared to research conducted in other parts of South Africa, the prevalence of abused cooking oil in the South Central Operational Entity for the eThekweni Municipality exceeds that found by studies conducted in other geographical areas. Kock's initial research in 1994 into the abuse of cooking oil showed that 30% of food outlets in Bloemfontein were guilty of using abused oil.²² The most recent survey showed that 15% of the samples did not meet regulatory requirements. In April 2003 samples analysed contained polymer levels of 58%, when regulatory levels is 16% with the highest PTG levels in the formal sector of the South African frying business was 75%.⁸

5.3 SUPERVISION AREAS IN THE SOUTH CENTRAL OPERATIONAL ENTITY WHERE THE USE OF ABUSED COOKING OIL IS MOST PREVALENT.

Based on the professional judgment of EHP's at the eThekweni Municipality, 80% of the oil samples should have tested as acceptable. This upper threshold was not reached by any one of the six supervision areas. All supervision areas performed at or below the lower threshold of 60% that was set at the beginning of the study. This is a matter of concern and requires action.

The reason for using the LQAS methodology was to assist EHP's to identify supervision areas that are particularly problematic with regards to the use of abused oil. This would allow the prioritisation of scarce human resources towards area that are performing poorly and are in particular need.²¹

Since none of the supervision areas reached the 80% threshold and the study established that there was an overall prevalence of 60% acceptable oil, 60% was then used as the upper threshold.

With reference to Table 9, the decision rule associated with the level of coverage was 9 (i.e. at least 9 of the outlets in each Supervision Area would need to comply) for the Oxifrit Test. Based on the Oxifrit Test more than 9 fast food outlets in each of the Supervision Areas did comply; so no Supervision Area was identified as requiring specific attention. The decision rule associated with the level of coverage for the Col Test was 11. Based on this test only Supervision Area 6 required intervention. The decision rule associated with the level of coverage for the Particle Count Test was 9. Based on this test Supervision Areas 5 and 6 were identified as requiring intervention. Lastly with regards to the Smell Test the decision rule associated with the level of coverage was 15, thus only Supervision Area 4 was found to be non-compliant.

5.4 REPORTED PRACTICES IN PRESERVING THE QUALITY OF CHIP OIL.

The observation checklist and the questionnaire were administered in order to establish the reported oil preservation practices that would help to explain the results pertaining to the prevalence of abused deep fried chip cooking oil.

5.4.1 Reported Preservation Practices

Overall the results showed poor oil preservation practices.

This is evident by the fact that:

- Almost one in four outlets had caked fryers.
- Almost 40% of outlets had oil that was 3 days or older in the fryer on the day of data collection.
- 64% of outlets reported that they changed their oil every 3 days or less frequently.
- Almost 60% of outlets strained or filtered their oil every second day or less frequently.
- 66% of outlets stored the oil in an unacceptable manner (in the fryer).
- 21% of outlets disposed of their oil unacceptably.

With reference to Table 9, a number of indicators were used to determine oil preservation practices. Counts that are underlined in Table 9 can be identified as those that fall below the decision rule and are in need of intervention. Due to financial constraints interventions will be prioritised in those Supervision Areas most in need. Table 9 clearly indicates Supervision Area 6 to have the most number of indicators falling below the decision rule, followed closely by Supervision Area 4. Based on this Supervision Area 6 will be prioritised for the intervention followed by Supervision Area 4.

5.5 RECOMMENDATIONS TO EHP'S AND MANAGERS/OWNERS OF THE FAST FOOD OUTLETS

The findings of the research project are of great concern, especially to the eThekweni Health Authority. Promoting good oil preservation practices is the first strategy to be employed by EHP's.

With regards to what practices to promote, the following must be considered:

- Multivariate logistic regression showed that in this study the factors significantly associated with the poor quality oil were a caked fryer and poor frequency of oil change. A fryer would become caked as a result of infrequent cleaning of the fryer. The frequency of oil change must be related to its quality. Thus frequent changing of oil is recommended.
- Checking the oil quality and knowing when to change used frying oil, are critical to maintaining good food quality and to operate within the law. For this purpose Quality Indicator Test Kits are available from various retailers to determine the quality of oil.¹¹ It would appear that owners/managers are not monitoring the quality of the oil in their outlets. The measures of association between the reported oil testing methods and the quality of the oil were surprising. Reporting to have tested the oil was unexpectedly associated with poor quality oil, albeit none of these associations were significant. This might be explained by the fact that a degree of misreporting must have occurred with regards to oil checking practices.

The benchmark test for testing the quality of the oil in this study was the Oxifrit Test. Utilising this test was possible because of laboratory resources made available to the researcher by the eThekweni Health Department. This form of testing may not be readily available to fast food outlets. Owners/Managers of fast food outlets could however use the Col Test to test the quality of their oil and determine when the oil requires to be changed. The Col Test has high sensitivity (75%), a high positive predictive value (86%) and high specificity (100%)

The Col Test is a colour indicator to determine the quality of the oil. The Standard colours are labeled numerically. When the colour of the test sample is compared against the corresponding colour of the standard sample obtained, the resulting number will determine the quality of the oil and whether the frying oil can be used further or discarded.¹³

Factors identified in the literature that contribute to the discolouration of the oil include:

Crumb degrading cause's dark oil colour, high fatty acid content, scorched and burned flavor leading to a short oil fry-life and poor quality fried food.⁶

Filtration of used oil should occur as often as necessary to prevent crumbs from degrading. It is recommended that frying oil be filtered once a day when crumb accumulation is minimal, once in a frying shift with moderate crumb accumulation, and two or more times in a shift when accumulation is heavy. Over half the outlets filtered their oil every second day or less frequently. This may indicate inadequate filtration, although filtration practices in this study were not assessed in relation to crumb accumulation.⁶

According to Frying Oil Safety, storing used oil in glass containers in the dark or in the refrigerator ensures a significant difference to the useful life span of the oil. The larger portion of outlets (66%) did not store their oil in an acceptable manner.⁸

Often toxic oils find their way back into the human and animal food chain. Legislation makes it clear that it is illegal to recycle used oil for human consumption. Used oils can be successfully reprocessed for chemical use, i.e. bio-diesel, low grade industrial lubricants, soaps, putty, etc. 80% of outlets reported acceptable disposal of used oil, however this was not verifiable in the study.⁸

Correcting the problem of abused deep fried chip cooking oil in the South Central Operational Entity requires action by EHP's to educate, monitor and enforce legal action against offenders. The Col Test would be a cost effective, feasible and assessable test to promote in fast food outlets as a check for the quality of oil.

A comprehensive intervention to be implemented by EHP's in Supervision Areas 6 and 4 will include a detailed health education programme, which will include:

- Promotion of good oil preservation practices (guidelines are included in Annexure 15.)
- Education on the effects of abused deep fried chip cooking oil on health.
- Monitoring condition of deep fried chip cooking oil by carrying out more frequent random oil sampling.
- Law enforcement: Educate owner/manager of the fast food outlet on the legislation with regards to abused cooking oils and the repercussions for sale for human consumption abused cooking oil which contains high levels of polar compounds and polymerized triglycerides.

EHP's will conduct health education at the fast food outlets, which will target owners, managers and all other food handler on the premises.

5.6 SUMMARY

The findings of the present study revealed that the prevalence of the use of abused deep fried chip cooking oil in the South Central Entity is unacceptable.

When seeking to identify which supervision areas to prioritise for intervention, Supervision Area 6 was found to perform consistently below the decision rule for most cooking oil practices.

The Col Test was identified as the test that should widely be disseminated among fast food outlets to promote regular monitoring of the quality of the oil.

An education intervention will include oil preservation practices as per guideline in Annexure 15.

CHAPTER 6

RECOMMENDATIONS

6. INTRODUCTION

Some recommendations have been presented in the previous chapter. This chapter summarises and builds on those recommendations.

6.1 FEEDBACK

Feedback on the findings of this study will be given to key role players within the eThekweni Municipality, and specifically within the Environmental Health Services. These role players include:

- The Head of the eThekweni Health Department
- The Head of Environmental Health Services
- The Divisional Manager for Food Safety,
- Environmental Health Practitioners responsible for education, monitoring and law enforcement at food premises.

6.2 PLAN OF ACTION

Due to limited human and financial resources, EHP's to prioritize Supervision Areas 2 and 4 for implementation of the following actions:

- Education with regards to oil preservation practices at fast food outlets. (Annexure 15). This will include reporting on the findings of the study, with regards to the factors associated with abused oil (condition of the fryer, and frequency of oil change), and the recommended method for monitoring the quality of the oil on site (COL test). EHPs should provide all outlets in Supervision Areas 2 and 4 with the COL test colour indicator chart to facilitate their own self-monitoring of the quality of the oil.
- Monitor quality of the oil by carrying out more frequent random oil sampling, in the first instance with the Oxifrit test.

- Enforce the law: institute legal proceedings against offenders of abused deep fried chip cooking oil, based on findings of the polar composition of the oil done at the Health Forensic Laboratory in Pretoria.

FURTHER RESEARCH

- Given the high prevalence of the use of abused cooking oils in the South Central Entity of the eThekweni Municipality, it would be important to establish the knowledge and practice of EHPs responsible for monitoring the quality of the oil at fast food premises. Based on the findings of this research, it may be necessary provide EHPs with refresher courses on monitoring abused cooking oil, the health hazards of abused oil, and its disposal. They may also need to be trained on the methods available to test the quality of the oil, and be provided with new Oil Testing Kits.
- It would also be important to establish what the prevalence of abused cooking oil would be in other parts of the eThekweni Municipality.
- This study forms a baseline assessment of the quality of oil at fast food outlets in the South Central Operational Entity. After a period of time (e.g. twelve months), during which the above plan of action would have been implemented, it would be important to do a follow-up assessment to establish whether there has been a change in the use of abused deep fried chip cooking oil at fast food outlets in the South Central Operational Entity. This further study could then also determine the polar compounds and polymerized triglycerides of oil found to be abused, and assess whether these are inline with current legislation.

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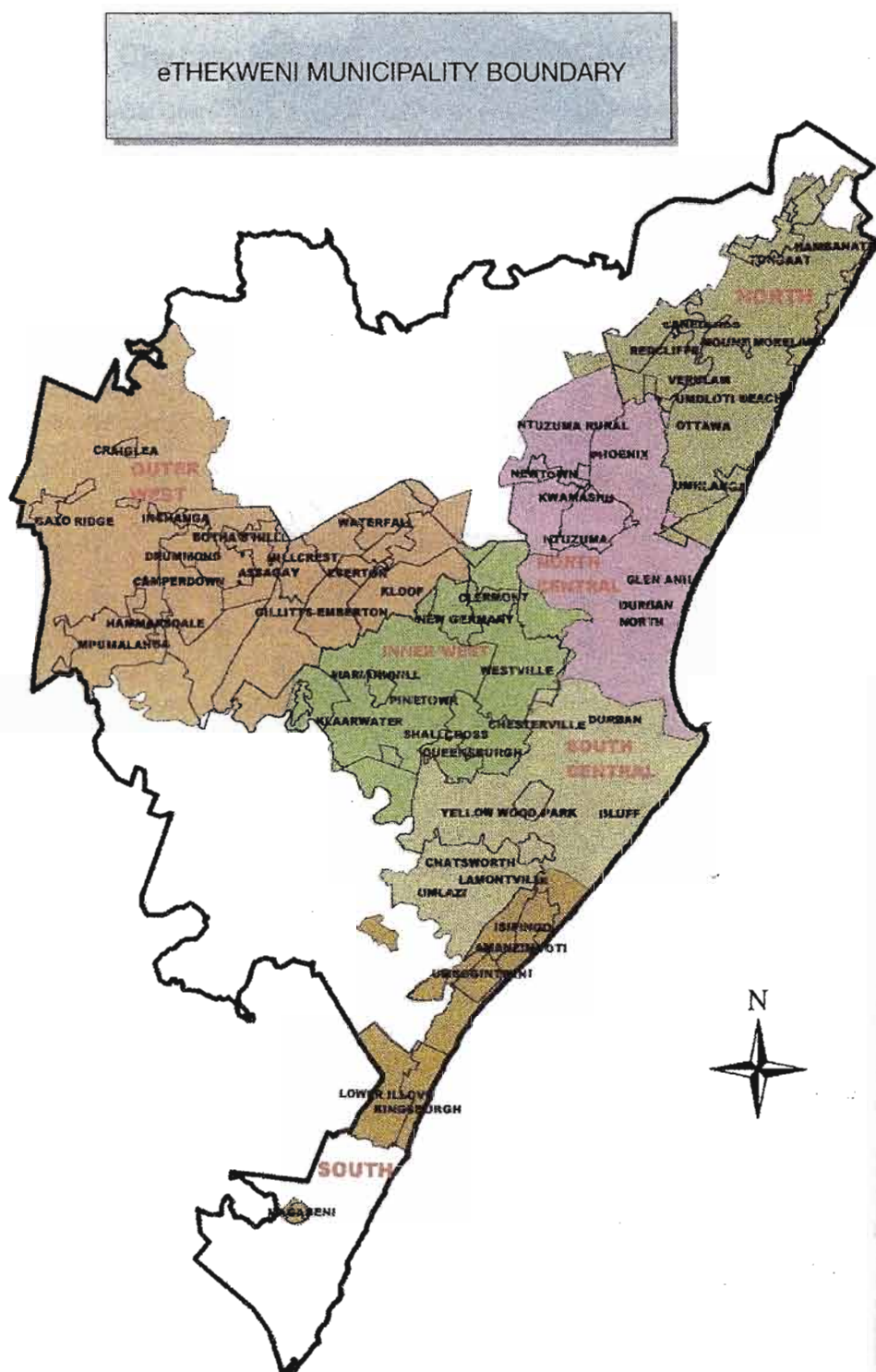
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Annexure 01: eThekweni Municipal Boundary



Annexure 02: The Six Supervision Areas in the South Central Operational Entity

(a)	Supervision Area 1	(b)	Supervision Area 2
	CBD		Bonela
	Esplanade		Waterval Park
	Harbour		Wiggins
	Maydon Wharf		Westridge
	Bayhead		Bulwer
	Van Riebeeck Park		Glenwood
	Ocean View		Congela
	Fynnlands		University
	Island View		Umkubaan
	Military		Ridgeview
	Cave Rock		
(c)	Supervision Area 3	(d)	Supervision Area 4
	Hillary		Jacobs
	Bellair		Wentworth
	Mount Vernon		Brighton Beach
	Coedmore		Treasure Beach
	Seaview		Austerville
	Umbilo		Stanvac
	Rossburgh		
	Mowat Quarries		
	Clairwood		
	Mount Clair		
	Mobeni		
	Mobeni Heights		
	Lamontville		
	Umhlatuzana		
	Kharwastan		
(e)	Supervision Area 5	(f)	Supervision Area 6

	Havenside		Merewent
	Bayview		Mondi
	Silverglen		
	Westcliff		
	Woodhurst		
	Croftdene		
	Arena Park		
	Montford		
	Moorton		
	Crossmoor		
	Risecliff		
	Klaarwater		
	Bul Bul Drive		

LQAS Table: Decision Rules for Sample Sizes of 12-30 and Coverage Benchmarks or Average Coverage of 10% to 95%

Sample Sizes	Coverage Benchmarks or Average Coverage																	
	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%
12	N/A	N/A	1	1	2	2	3	4	5	5	6	7	7	8	8	9	10	11
13	N/A	N/A	1	1	2	3	3	4	5	6	6	7	8	8	9	10	11	11
14	N/A	N/A	1	1	2	3	4	4	5	6	7	8	8	9	10	11	11	12
15	N/A	N/A	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	13
16	N/A	N/A	1	2	2	3	4	5	6	7	8	9	9	10	11	12	13	14
17	N/A	N/A	1	2	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18	N/A	N/A	1	2	2	3	5	6	7	8	9	10	11	11	12	13	14	16
19	N/A	N/A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
20	N/A	N/A	1	2	3	4	5	6	7	8	9	11	12	13	14	15	16	17
21	N/A	N/A	1	2	3	4	5	6	8	9	10	11	12	13	14	16	17	18
22	N/A	N/A	1	2	3	4	5	7	8	9	10	12	13	14	15	16	18	19
23	N/A	N/A	1	2	3	4	6	7	8	10	11	12	13	14	16	17	18	20
24	N/A	N/A	1	2	3	4	6	7	9	10	11	13	14	15	16	18	19	21
25	N/A	1	2	2	4	5	6	8	9	10	12	13	14	16	17	18	20	21
26	N/A	1	2	3	4	5	6	8	9	11	12	14	15	16	18	19	21	22
27	N/A	1	2	3	4	5	7	8	10	11	13	14	15	17	18	20	21	23
28	N/A	1	2	3	4	5	7	8	10	12	13	15	16	18	19	21	22	24
29	N/A	1	2	3	4	5	7	9	10	12	13	15	17	18	20	21	23	25
30	N/A	1	2	3	4	5	7	9	11	12	14	16	17	19	20	22	24	26

For all coverage benchmarks (except where noted) LQAS is at least 92% sensitive and specific

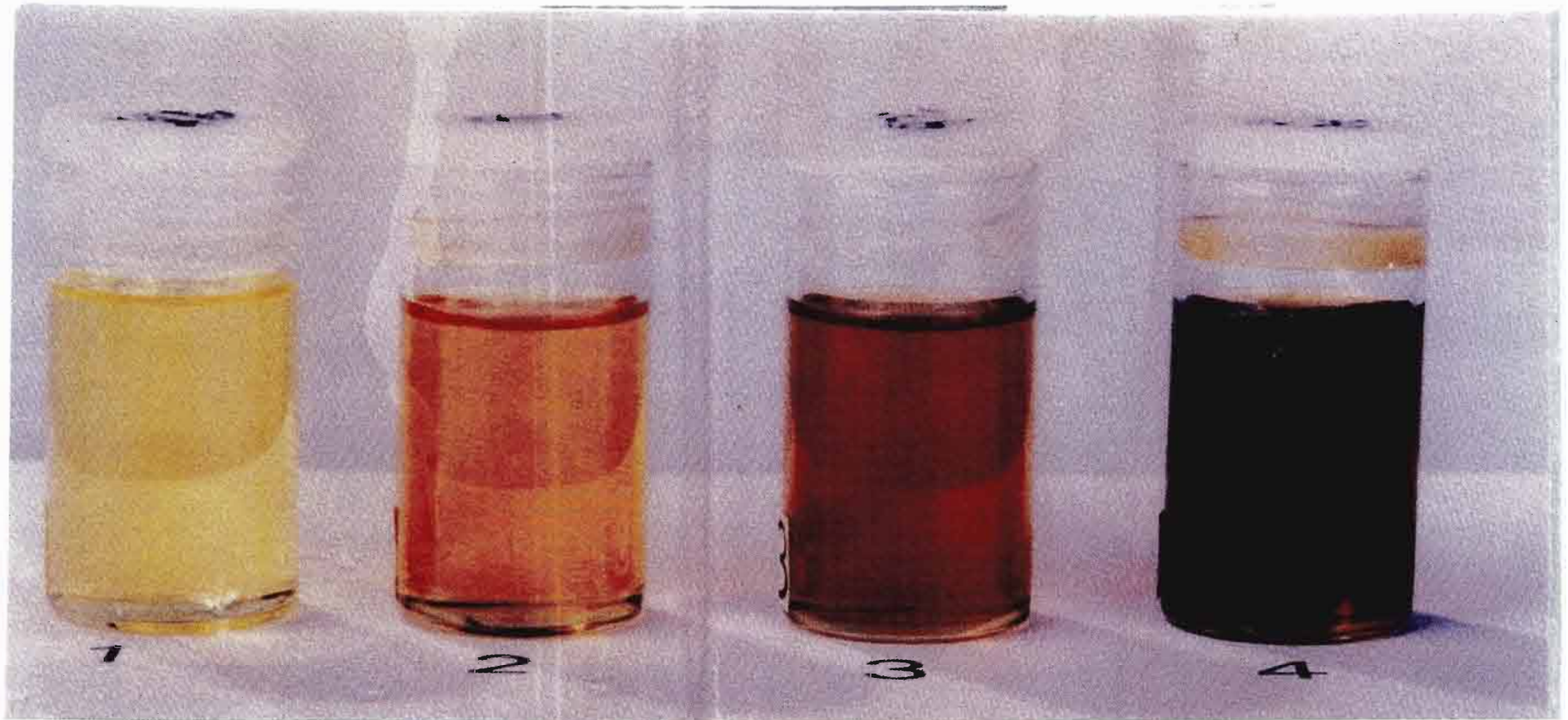
N/A = Not Applicable -- Indicates that LQAS should not be used since coverage is too low for LQAS to detect.

Alpha and Beta Errors are > 10%

Alpha and Beta Errors are > 15%

Annexure 04: COL Test (Colour Indicator Test)

COL TEST – ON-THE-SPOT TEST (Colour Indicator Chart)



Key:

1)	Good
2)	Still Good
3)	Borderline
4)	Replace

Annexure 05 : Deep Fried Chip Cooking Oil Sampling Form

USED COOKING OIL SAMPLE FORM

DATE:

SAMPLE CODE	TYPE/S OF FOOD PREPARED IN OIL	OXIFRIT TEST RESULTS			COL TEST				TEMPER- ATURE OF OIL	COMMENT
		Bad	Replace	Good	Good (1)	Still Good (2)	Borderline (3)	Replace (4)		

THIS FORM MUST BE COMPLETED BY ENVIRONMENTAL HEALTH PRACTITIONER

ENVIRONMENTAL HEALTH PRACTITIONER

REFERENCE CODE

NB: To record Col Test result please ✓ (tick) appropriate box

SENIOR LABORATORY TECHNOLOGIST

Mrs K S Pather

Annexure 06 : Observational Checklist

Inspector Code: _____

Ref No.: _____

OBSERVATIONAL CHECKLIST
AT FASTFOOD OUTLET

Quality of deep fried chip cooking oil at fast food outlets in South Central Operational Entity within eThekweni Municipality.

KEY: YES = 1
 NO = 2

1.	Temperature of oil in the fryer	YES	NO
	(a) ≤ 80°C		
	(b) 80°C to 100°C		
	(c) 100°C to 160°C		
	(d) higher than 160°C		
2.	Colour of oil sample taken (as per sample colour indicator chart)	YES	NO
	(a) Good		
	(b) Still Good		
	(c) Borderline		
	(d) Replace		
3.	Particles in the oil within chip fryer	YES	NO
	(a) Approx less than 10		
	(b) Approx more than 10 but less than 30		
	(c) Approx more than 20 but less than 40		
	(d) More than 40		
4.	Smell of oil sample taken	YES	NO
	(a) Fresh		
	(b) Rancid		
5.	General hygienic condition of the chip fryer	YES	NO
	(a) Good (no build up of encrusted oil)		
	(b) Caked with encrusted oil		

Annexure 07 : Questionnaire

Ref No.: _____

Inspector Code: _____

QUESTIONNAIRE

Quality of deep fried chip cooking oil at fast food outlets in South Central Operational Entity within eThekweni Municipality.

KEY: YES = 1
 NO = 2

1.1 Type of fat/oil used for deep frying

- (a) Vegetable
- (b) Animal

YES NO

1.2 Approximate age of oil in the deep fryer

- (a) 1 to 3 days
- (b) 3 to 5 days
- (c) 5 to 7 days
- (d) more than 7 days

YES NO

1.3 How often is the used oil in the deep fryer changed

- (a) Daily
- (b) Every 2 to 3 days
- (c) Every 4 to 5 days
- (d) Every 5 to 7 days
- (e) After 7 days

YES NO

1.4 How often is the used chip oil in the fryer strained/filtered

- (a) More than once a day
- (b) Once a day
- (c) Every 2 to 3 days
- (d) Every 4 to 5 days
- (e) Not at all

YES NO

1.5 At approximately what temperature are the chips fried at

- (a) $\leq 80^{\circ}\text{C}$
- (b) $80^{\circ}\text{C} - 100^{\circ}\text{C}$
- (c) $100^{\circ}\text{C} - 120^{\circ}\text{C}$
- (d) $120^{\circ}\text{C} - 160^{\circ}\text{C}$
- (e) Higher than 160°C

YES NO

1.6 How many kg of potatoes were purchased in the previous month?

- (a) ≤ 50 kg
- (b) 50 kg to 100 kg
- (c) 100 kg to 150 kg
- (d) 150 kg to 200 kg
- (e) More than 200 kg

YES NO

1.7 How much oil was purchased in the previous month for frying chips?

- (a) Less than 50ℓ
- (b) More than 50ℓ less than 100ℓ
- (c) More than 100ℓ less than 200ℓ
- (d) More than 200ℓ

YES NO

1.8 How is the used oil from the chip fryer stored at the end of the day?

- 1) Emptied and kept in the fridge
- 2) Emptied and kept in container/bottle at ambient temperature
- 3) Still kept in the fryer

YES NO

1.9 How do you know when the oil needs to be discarded?

- (a) chemical testing
- (b) colour
- (c) smell
- (d) taste

YES NO

1.10 What means of disposal do you use for the old oil

- (a) Taken by private company
- (b) Taken by Durban Solid Waste with the general refuse
- (c) Pour it down the drain
- (d) Given to staff
- (e) Sold to public

YES NO

Thank You

DATE: _____

INTERVIEWER CODE: _____

Annexure 08 : Observational Checklist with Score

Inspector Code: _____

Ref No.: _____

OBSERVATIONAL CHECKLIST
AT FASTFOOD OUTLET

Quality of deep fried chip cooking oil at fast food outlets in South Central Operational Entity within eThekweni Municipality.

KEY: YES = 1

NO = 2

1.	Temperature of oil in the fryer	YES	NO
(a)	≤ 80°C (2)		
(b)	80°C to 100°C (2)		
(c)	100°C to 160°C (1)		
(d)	higher than 160°C (0)		
2.	Colour of oil sample taken (as per sample colour indicator chart)	YES	NO
(a)	Good (3)		
(b)	Still Good (2)		
(c)	Borderline (1)		
(d)	Replace (0)		
3.	Particles in the oil within chip fryer	YES	NO
(a)	Approx less than 10 (3)		
(b)	Approx more than 10 but less than 30 (2)		
(c)	Approx more than 20 but less than 40 (1)		
(d)	More than 40 (0)		
4.	Smell of oil sample taken	YES	NO
(a)	Fresh (2)		
(b)	Rancid (0)		
5.	General hygienic condition of the chip fryer	YES	NO
(a)	Good (no build up of encrusted oil) (2)		
(b)	Caked with encrusted oil (0)		

Annexure 09 : Questionnaire With Score

Ref No.: _____

Inspector Code: _____

QUESTIONNAIRE

Quality of deep fried chip cooking oil at fast food outlets in South Central Operational Entity within eThekweni Municipality.

KEY: YES = 1

NO = 2

1.1	Type of fat/oil used for deep frying		YES	NO
	(a) Vegetable	(4)		
	(b) Animal	(1)		
1.2	Approximate age of oil in the deep fryer		YES	NO
	(a) 1 to 3 days	(3)		
	(b) 3 to 5 days	(1)		
	(c) 5 to 7 days	(1)		
	(d) more than 7 days	(0)		
1.3	How often is the used oil in the deep fryer changed		YES	NO
	(a) Daily	(3)		
	(b) Every 2 to 3 days	(1)		
	(c) Every 4 to 5 days	(1)		
	(d) Every 5 to 7 days	(1)		
	(e) After 7 days	(0)		
1.4	How often is the used chip oil in the fryer strained/filtered		YES	NO
	(a) More than once a day	(3)		
	(b) Once a day	(2)		
	(c) Every 2 to 3 days	(1)		
	(d) Every 4 to 5 days	(0)		
	(e) Not at all	(-1)		

1.5 At approximately what temperature are the chips fried at

- (a) $\leq 80^{\circ}\text{C}$ (2)
 (b) $80^{\circ}\text{C} - 100^{\circ}\text{C}$ (2)
 (c) $100^{\circ}\text{C} - 120^{\circ}\text{C}$ (1)
 (d) $120^{\circ}\text{C} - 160^{\circ}\text{C}$ (1)
 (e) Higher than 160°C (0)

YES NO

1.6 How many kg of potatoes were purchased in the previous month?

- (a) ≤ 50 kg (3)
 (b) 50 kg to 100 kg (2)
 (c) 100 kg to 150 kg (1)
 (d) 150 kg to 200 kg (1)
 (e) More than 200 kg (0)

YES NO

1.7 How much oil was purchased in the previous month for frying chips?

- (a) Less than 50ℓ (3)
 (b) More than 50ℓ less than 100ℓ (2)
 (c) More than 100ℓ less than 200ℓ (1)
 (d) More than 200ℓ (0)

YES NO

1.8 How is the used oil from the chip fryer stored at the end of the day?

- (a) Emptied and kept in the fridge (2)
 (b) Emptied and kept in container/bottle at ambient temperature (1)
 (c) Still kept in the fryer (0)

YES NO

1.9 How do you know when the oil needs to be discarded?

- (a) chemical testing (3)
 (b) colour (1)
 (c) smell (1)
 (d) taste (1)

YES NO

1.10 What means of disposal do you use for the old oil

- (a) Taken by private company (3)
- (b) Taken by Durban Solid Waste with the general refuse (2)
- (c) Pour it down the drain (1)
- (d) Given to staff (0)
- (e) Sold to public (-1)

YES NO

Thank You

DATE: _____

INTERVIEWER CODE: _____

Annexure 10 : Ethical Approval



UNIVERSITY OF
KWAZULU-NATAL

Research Office

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

Nelson R Mandela School of Medicine

Private Bag 7, Congella 4013

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604769

Fax: 27 31 2604609

Email: buccas@ukzn.ac.za

Website: www.ukzn.ac.za

15 September 2006

Mrs Theresa Padayachee
eThekweni Municipality
Environmental Health Services
9 Old Fort Place
DURBAN
4001

PROTOCOL: Quality of deep fried chip cooking oil at fast food outlets in the South Central Entity within the eThekweni Municipality. Mrs Theresa Padayachee Environmental Health Practitioner. Ref: EXP004/06

EXPEDITED APPLICATION

Dear Mrs Padayachee

This letter serves to notify you that at a full sitting of the Biomedical Research Ethics Committee meeting held on 15 August 2006, the Committee RATIFIED the sub-committee's decision to approve the above study.

Yours sincerely

SURAIYA BUCCAS
Ethics Research Administrator

CR/en

Annexure 11 : Permission to Conduct Study From Food Safety Department

Health, Safety and Social Services Cluster
Health Unit

Durban 4001

P O Box 2443
Durban 4000

Tel: (031) 311-1111
Fax: (031) 311-3530

Website: <http://www.durban.org.za>



Our Ref :

Your Ref :

Enquiries :

ENVIRONMENTAL HEALTH SERVICES

(Mr U Singh)

Telephone : 311-3575

2006-05-08

Ms Theresa Padayachee
52 Canary Street
KHARWASTAN
4092

Dear Ms Theresa

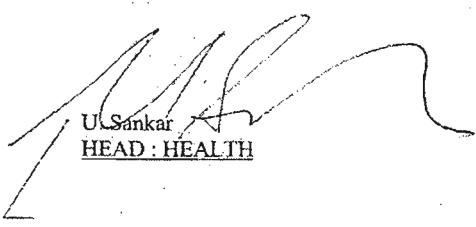
**REQUEST TO CONDUCT RESEARCH ON QUALITY OF DEEP FRIED CHIP COOKING OIL AT
FAST FOOD OUTLETS IN THE SOUTH CENTRAL OPERATIONAL ENTITY WITHIN
ETHEKWINI MUNICIPALITY**

Your undated letter refers.

Please be advised that authority is granted for you to conduct a research regarding quality of deep fried chip cooking oil at fast food outlets in the South Central Operational Entity within eThekweni Municipality provided that:

- (a) Confidentiality is maintained;
- (b) The Department is acknowledged;
- (c) The Department receives a copy of the report on completion.

Yours faithfully


U. Sankar
HEAD : HEALTH

Address correspondence to the Head : Health



Annexure 12 : Consent Document

CONSENT DOCUMENT

Consent to Participate in Research

I have read this form, or had it read to me, and voluntarily agree to participate in a research study. The purpose of the study, the procedures, and the risks and benefits have been explained to my satisfaction. My signature indicates that I consent participation to the research study.

Signature of Participant

Date

Signature of Witness
(Where applicable)

Date

Signature of Translator
(Where applicable)

Date

Annexure 13 : Information Document for Study Participants
INFORMATION DOCUMENT FOR STUDY PARTICIPANTS

STUDY TITLE : The quality of used deep fried chip cooking oil in fast food outlets within South Central Entity of eThekwin Municipality.

GREETING: Good Day

INTRODUCTION

My name is _____, an Environmental Health Practitioner (EHP) of eThekwin Municipality Health Department. I am assisting my colleague, Theresa Padayachee, who is currently conducting a study for her Masters Degree in Public Health. The duration for completion of her study is one year, from planning the study to the final write up.

The purpose of her study is to determine the quality of deep fried chip cooking oil at fast food outlets in the South Central Entity within eThekwin Municipality. This study will identify areas where the problem is prevalent via Lot Quality Assurance Sampling (LQAS) and the oil sampling analysis. A suitable plan of action will be recommended, to control the unsavoury practices of the use of abused cooking oil for the area in which this is most prevalent. The study will be beneficial to all Environmental Health Practitioners to target areas that are particularly problematic to ensure the safe use of cooking oil. The study will also be indirectly beneficial to all fast food consumers.

My colleague would like to use information from this inspection for research purposes. I am requesting you to take part in the research project.

What is involved in the study

As a participant you are expected to avail yourself for approximately 30 minutes of the inspection or you can delegate somebody to assist. Data collection will be conducted, but data analysis will enable the Researcher to achieve the objectives of the study. Sampling will be undertaken by myself.

Standard procedure being done in the study

Used chip cooking oil samples will be purchased from your premises and sampling will be conducted according to FCD Act. The sample will be taken in 100ml sampling bottle. The sample will then be transported to the microbiology laboratory of eThekweni Municipality placed in a cooler box, where the analysis will be conducted by a qualified Laboratory Technologist. All glassware used in the testing is autoclaved under the supervision of the Laboratory Technologist in order to ensure that it is sterilized before use. The contents of the test and remaining oil not utilized in the analysis will be suitably secured, sealed and disposed of by the Laboratory personnel (Laboratory Assistant) in an appropriate refuse facility which is in a secured area, free of public access within the premises of eThekweni Health Department. The refuse will be collected by the truck from Durban Solid Waste Department (DSW) which comes twice a week, after which it will then be transported to the Municipal Land Fill site at Bisasar Road, Springfield. The disposal will be done under security and supervision of DSW.

An observational Checklist will be filled out by the data collector. A Questionnaire will be administered to the owner/manager. This will entail a few questions pertaining to the current preservation of the oil. The end result will enable the Researcher to give an overall rating of the quality of the oil of all fast food outlets in the South Central Entity within eThekweni Municipality.

Number of people that will take part in the study

100 Fast food establishments owners / managers and 5 qualified EHPs.

Risk of being involved in the study : Low risk

Benefits of being in the study -

The benefits to you as the owner of a fast food establishment may be twofold:

Firstly, should the results of the study indicate oil quality is satisfactory, this information may be beneficial in that official publications could be used as an advertising mechanism for the eThekweni Municipality as a whole, indicating a superior oil quality standard amongst the fast food outlets within the South Central Entity.

Secondly, should the results indicate otherwise, the study will then emphasis remedial measures and advise on improving oil quality and safety. This will prove a valuable tool in the operation of a safe and healthy fast food outlet.

Participation is voluntary

The study will be conducted in partial fulfillment of the requirements for a Masters Degree in Public Health for my colleague, it is important to note that I am conducting this inspection as part of my official duties. Participation in the research however, is voluntary, you will not be penalized if you refuse to participate and you may discontinue participation at any time.

Confidentiality

For the purpose of this research all personal information will be kept confidential and any access by any person to obtain such details from the researcher or other participants will be forbidden.

What to do if you have questions or problems:

You may contact any of the following persons at any time if you have questions about the research.

Contact Details of Researcher

Mrs Theresa Padayachee

Address : eThekweni Health Department
9 Old Fort Place
Durban
4000

Phone Number: 031-3113662

Fax Number: 031-3113530

Cell Number: 084 603 4585

Project Supervisor

Dr Anna Voce

Department of Community Health

University of KwaZulu Natal

Phone Number: 031-2604493

Project Funder
Mr U Singh
Divisional Manager : Food Section
eThekweni Municipality
9 Old Fort Place, Durban
Phone Number: 031-3113575

Biostatistician
Tanya Esterhuizen
Phone Number: 2604522
Email: esterhuizent@ukzn.ac.za

Biomedical Research Ethics Committee
University of KwaZulu Natal
Prof. Suraya Buccas
Phone Number: 2604769
Email: buccas@ukzn.ac.za

LEGAL REQUIREMENTS.

Regulations under the Foodstuffs, Cosmetic and Disinfectant Act, 1972 (Act 54 of 1972) were published on 16 August 1996.

It is a criminal offense to use or sell used cooking oil or fat, which contains more than 25% polar compounds and/or 16% polymerized triglycerides.

These products are formed during extensive use of any type of frying oils and fats.



Compiled by: Theresa Padayachee

9 Old Fort Place
Durban
4001

Phone: (031) 3113662

Rev 1.0

Annexure 14 : Cooking Oil Brochure

HINTS AND TIPS ON PRESERVING THE QUALITY OF FRYING OIL.



ABUSE OF COOKING OIL.

The extended use and overheating of frying or cooking oils causes a build up of chemical impurities which may cause diarrhea, contribute to the hardening of the arteries, damage to the liver and kidneys and lead to cancer.

FACTORS THAT CONTRIBUTE TO THE ABUSE AND DETERIORATION OF FRYING OILS.

1. The repeated and intermittent heating of the frying oil.
2. Contamination of the frying oils by small food particles remaining in the fryer.

3. Increase in the demand for fried foods.
4. The increase in the cost of fresh oil to replace the used oil.
5. The difficulty in disposing of the oil.

HINTS & TIPS ON PRESERVING THE QUALITY OF FRYING OIL.



6. Heat the oil slowly.
7. Maintain a constant temperature of the oil during the frying process. Do not heat the oil over 180 °C.
8. Avoid the use of a copper or bronze based fryer that is in contact with the heating frying oil.
9. To achieve an oil replacement rate of over 30%, filter the oil daily and remove loose particles from the surface.
10. Clean the fryer daily.

11. Keep the frying oil covered when not in use.

12. Maintain oil to food ratio of no more than 6 to 1 for each frying batch. Overloading of a fryer causes a decrease in frying temperature which results in longer frying time, slower food production and greaser foods.

13. Do not use oil that is deteriorating.

14. Make sure that the food portions are all of the same size.

15. Reduce the residue of batter or bread crumbs and use batter whenever possible.

16. Never add new oil to old oil.

17. Allow frozen foods to thaw before frying.

18. Remove all excess moisture from food.

19. Soak potato chips in water to remove all excess starch and then drain well before frying.



OIL PRESERVATION GUIDELINE

Hints and Tips on the Use of Frying Oils (Code of Practice)

One of the biggest expenses in the fried food industry is the oil used for frying or cooking. By following the simple guidelines, the cost effectiveness of oil usage can be greatly improved which will result in good quality of fried foods, more satisfied customers leading to bigger turnovers and better profits.²⁵

- (a) Choosing cooking oil of good quality and consistent stability.
- 1) Although one company issues a certificate of compliance with an approved logo to certify that the oil complies with certain standards, this logo can create a false sense of security if standard oil management practices are not followed. User can still abuse certified or approved oil.
 - 2) Heat the oil slowly.
 - 3) Maintain a constant temperature of the oil during the frying process. Do not heat the oil over 180°C.
 - 4) Avoid the use of a copper or bronze based fryer that is in contact with the heated oil. Use stainless steel frying vessels instead.
 - 5) Use properly designed equipment.
 - 6) Filter the oil daily and remove loose particles from the surface regularly.
 - 7) Clean the fryer daily.
 - 8) Keep the frying oil covered when not in use.
 - 9) Use only good oil in pressure frying.
 - 10) Cool oil after frying, and not leaving it hot and idle.
 - 11) Overloading of a fryer causes a decrease in frying temperature which results in longer frying time, slower food production and greasier foods.
 - 12) Do not use oil that is deteriorating.
 - 13) Make sure that the food portions are all of the same size.
 - 14) Reduce the residue of batter or breadcrumbs and use batter wherever possible.
 - 15) Allow frozen foods to thaw before frying.
 - 16) Remove all excess moisture from foods to delay oxidation of oil.

- 17) Soak potato chips in water to remove all excess starch and then drain well before frying.
- 18) Frying above the recommended temperature will not speed up the cooking process, but will simply burn the products and age the oil and fats. Frying below the recommended temperature will result in poor colouring of the products, excessive oil absorption and poor quality of food.
- 19) Avoid salting or seasoning the food over the pan, as this can accelerate the breakdown of the oil.
- 20) Oil, which foams excessively or smokes prematurely, should be discarded immediately as these are signs of oil degradation.
- 21) Keep oil covered after use to avoid unnecessary oxidation and breakdown of oil through ultraviolet light. Both of these will turn the fatty acid rancid.
- 22) Provide adequate training to personnel.
- 23) Testing cooking oil frequently throughout frying process.²⁵

More Detailed Tips on the use of Frying Oils

In order to maximize frying oil usage legally as well as obtaining good fried food quality, the following Frying Tips should be adhered to.

Start-up: Always heat frying oil (refers to any type of well refined frying fats and oils collectively) to appropriate temperatures, which is usually from 160°C to 190°C.

Immediately after reaching this temperature, frying should commence since heating oil earlier than needed will stress the oil and result in unnecessary breakdown, which will shorten its usable life span.

Variable demand: The demand for fried food throughout the production shift should be monitored and taken into account in order to anticipate when fryers should be switched on or off. Keeping oil at high temperatures for extended periods without frying will lead to unnecessary breakdown.

Batch size: The maximum batch size should be set so that the oil temperature in a new batch recovers rapidly to the frying set level reached at the end of the previous frying cycle.¹⁸

Fryer idling: It is important that fryers not needed for frying are turned off. When keeping oil temperature any higher than necessary causes breakdown of oil, which shortens its useable life.

Crumb control: Crumbs (small pieces of food) in the frying oil will lead to premature oil breakdown, which will influence the quality of the fried food. Crumb control can be achieved by separating particles in the food such as chips before entering the fryer and filtering crumbs present in the fryer by skimming off the floating pieces.

Filtration: Filtration of used oil should occur as often as is necessary to prevent crumbs from degrading. Crumb degrading causes dark oil colour, high fatty acid content, scorched and burned flavour leading to a short oil fry-life and poor quality fried food. Frying oil should be filtered once a day when crumb accumulation is minimal, once a frying shift with moderate crumb accumulation and two or more times a shift is needed when crumb accumulation is heavy.

Oil level: During the frying process, let the oil level decrease to a minimum acceptable level towards end of production. This will allow for maximum fresh oil addition and enhanced frying oil quality at the start of the next batch production period.

Fryer shutdown: Turn fryer off immediately after the last batch of food has been fried in order to prevent unnecessary breakdown. This should be followed by oil filtering cleaning of fryer and covering of fryer to prevent contamination by foreign materials.²⁵

Trouble Shooting Guide: Remedial Steps

The points to follow indicate problems that can be encountered during the frying process. Remedial steps are indicated.

Foaming:

Foaming, which resembles beer foam, occurs when oil degrades due to high temperatures and over-use. This oil should immediately be discarded. The following can contribute to premature foaming:

Salt: Excess salt may be added especially during rush hours resulting in foam formation through soap formation and direct oil breakdown.²⁶

Polymerised oil: Broken down oil contains brown gum like material that accumulates on temperature sensing probes, heating elements of electric fryers, around the perimeter of the fryer at the fill line and on frying baskets causing premature foaming.

This material is highly broken down oil resulting from inadequate cleaning and prolonged exposure to high frying temperatures.

Volatile breakdown products: Exhaust fans over fryers allow volatile fat breakdown products liberated from the oil surface to condense on filter screens and on the inside lining the fume hood. If left unattended, condensation could accumulate to a point where these compounds can drip back into the frying oil and cause rapid deterioration.

Boil-out compound residues: This is important to remove polymerized oil from the fryer and should be followed by rinsing with copious amounts of water to remove any residues, which may deteriorate oil in use.

Exposure to copper and brass: Inspect thermocouples and frying baskets daily since they may be plated with copper or brass and can cause soap formation and hence premature oil breakdown.

Topping up with used oil: Do not use used oil for topping up since this can cause foaming and rapid breakdown of the fresh oil through compounds already in the used oil.

Overheating: Frying at temperatures higher than 200°C, causes accelerated oil breakdown, which may result in premature foaming and reduced fry-life.

Consequently, the oil temperature of the oil should be measured routinely to verify the accuracy of the thermostat.

Premature smoking:

High amounts of oil breakdown products lead to early smoking of used oil. Smoking of oil is also an indicator of oil degradation and can happen as follows:

Poor filtration and skimming: these results in product remnants remaining in the oil during frying, which eventually char and liberate smoke.

Boil-out compound residues: These compounds promote oil breakdown products to form. These oils easily smoke at normal frying temperatures.

Overheating: Too high temperatures cause faster breakdown of frying oil causing premature smoking. A faulty temperature sensing probe or a thermostat, which needs recalibration, often causes this. This should routinely be verified with an adequate thermometer.

Type of product to be fried: If product is coated, “dust” or “powder” may be released into the frying oil causing premature smoking and oil breakdown.

Premature darkening

This may be caused by several factors and include:

Inadequate filtration and skimming: When burned remnants are allowed to accumulate in the fryer, it will stain the oil and cause premature darkening.

Overheating: Oil darkening is enhanced due to the formation of oil breakdown products formed at too high oil temperatures.

Improper fryer loading: Make sure the frying oil covers the temperature probe. If not, the probe will heat up until the air around the uncovered probe reaches the desired temperature – causing the oil to be burned and to start smoking or even burst into flames.

Bad flavours and odours:

“Off” flavours and odours may arise due to the following:

Topping up: When oil is topped up with used oil, the flavours and odours from oil breakdown as well as from food previously fried in the used oil will be carried over.

Improper filtration: Fish fryers and fryers used to fry highly spiced products should always be filtered last to prevent flavour and odour carry-over.

Cross contamination with different frying oils: Different oils have unique flavour profiles and stabilities towards temperature breakdown. Always use one type of oil to minimise “off” flavours and odours.¹⁹

Oil quality monitoring:

Checking oil quality and knowing when to change used frying oil, are critical to maintaining good food quality and to operate within the law. For this purpose quality indicators (Test Kits available from various retailers) are used in combination with appropriate thermometers in order to control frying oil temperatures during frying.²⁶

Another Solution to the Problem: Adopt Stewards Principle

Based on more than 10 years experience in this field, SAFOI is convinced that the implementation of the Steward’s Principle or Product Stewardship (being responsible for product from cradle to grave) in this industry will decrease oil abuse and the on-selling of these unhealthy oil wastes to the poor.²⁷

They place the biggest responsibility on the shoulders of the manufacturers and retailers. Some states in the United States and Canada have even developed product stewardship-type legislation for selected products.²⁷

“Product steward-ship recognises that product manufacturers can, and must, take on new responsibilities to reduce the environmental footprint of their products”.²⁷

The Steward’s principle can be performed as follows:

- The oil distributors (manufacturers and retailers) together with the frying establishments take responsibility for the quality of the oil when purchased/ distributed (i.e. test oils at external laboratories of repute).
- Maintaining the quality during use (i.e. ensure it is not abused by using appropriate frying procedures and test kits).
- Discard oil responsibility (i.e. within regulatory limits).²⁷

In the latter case, the distributor draws a sample at random from the used oil collected, which is then analysed for breakdown (make sure it is within regulatory limits). The results are communicated to the establishment’s management.²⁷

The Steward’s Principle as conducted by Refill Oil:

- Refill Oil only sells fresh oil, previously approved by a reputable external laboratory such as SAFOI to frying establishments. Any reputable external laboratory can be used for this purpose.
- The company trains clients on how to use various kinds of oils in the frying processes and when/how to discard them.
- It collected only frying oil waste within regulatory limits of breakdown from frying establishments. These establishments are contractually bound to deliver approximately 35% of fresh oil used, as waste. This ratio has been acknowledged for most frying processes.
- Refill Oil issues certificates to those establishments which has proved that they can use oil under well-controlled conditions and discard their used oils with regulatory limits i.e. 16% polymerized triglycerides (PTGs). When in breach, the certificates are removed.²⁷