QUANTITATIVE AND QUALITATIVE ANALYSES OF WASTES FROM NASCO FOODS NIGERIA LIMITED

BY

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CERTIFICATION

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DEDICATION

I dedicate this research project, first to God Almighty for giving me breath and the ability to complete this study. Secondly to the love of my life, my parents, for being the greatest influence behind my success. Also to my younger ones for their understanding and sacrifices.

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My foremost thanks are to Almighty Allah, the giver of life for his unfailing kindness and faithfulness to me throughout my life pursuits.

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ABSTRACT

This study was carried out to determine both qualitative and quantitative analyses of wastes from Nasco Foods Nigeria Limited. In addition to monitoring the quantities of wastes generated from this industry, the solid and liquid wastes were collected for analysis. The parameters analyzed for, comprises of nutritional properties of solid wastes and the physical, organic and chemical properties of the liquid wastes. The study shows that the quantity of solid waste produced by Nasco foods Nigeria Limited is 3600 tonnes/year and 100,000 hectoliters of liquid wastes per year. The qualitative test carried out on the liquid wastes shows that the Total Dissolved Solid (TDS)- 210.0mg/l, Chemical Oxygen Demand (COD) –200.0mg/l, and Biochemical Oxygen Demand (BOD), - 150.0, ranked significantly high compared with other parameters analyzed in the liquid waste. This indicates that there is the danger of environmental degradation if proper disposal treatments are not adopted.

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CHAPTER ONE

INTRODUCTION

Food plays a central role in all of our lives, indeed it is the essential requirement for existence. The high demand for processed food coupled with technology transfer from developed countries has influenced the emergence of food processing industries in Nigeria, with many indigenous and foreign food processing industries springing up.

Food processing industries in the country are so many that they could be sub divided into thirteen categories. These are: The Breweries; Starch and miscellaneous food products; Soft drinks and carbonated water; Flour and grain milling; Meat poultry and fish; Tea; coffee and other beverages; Fruit juices; Animal feed; Sugar; Distilleries and blending spirits; Cocoa chocolate and sugar confectioneries; Agricultural and food; Chemical and industrial packaging (Ojo, 1997).

The raw materials for the food industry are mainly agricultural products like cocoa, palm kernel, cereals, legumes, sugar cane and fruits. These inputs generate finished products like beverages (Bournvita, Milo, Pronto) oil palm, cornflakes, Soya-oil, vegetable oil, sugar cubes, and fruit drinks (fruit juice). The finished products are always accompanied by waste products which can be solid, liquid or gas.

The food processing industry provides food products for immediate or future human consumption and by products for use in various industries e.g. livestock industry. The industry generates large volumes of wastewater and solid waste and may also be a source of air pollutants. Wastewater arises mainly from leaks, spills and equipment wash out. Large volumes are also generated in the washing operations to remove soil, pesticides and skin from fruits and vegetables.

Our understanding of the relationship between environment and industrial development has undergone a considerable change over the past 10 – 15 years. At the end of 1960s, the view was that if you want to have development, then the price to pay would be a loss in environmental quality. That view has been overturned as we have come to realise that environment and development are interdependent, in other words, without conservation, you cannot have development and development is an integral part of conservation. Thus, there is an upsurge of interest in preserving a naturally and ecologically balanced environment which is contrary to the situation in the past. This is in consonance with a world wide clamour to reduce both municipal and industrial wastes, since they are potential pollutants to the environment.

A review of some specific wastes on Nigeria's environment are solid waste, sewage, industrial waste, oil spillage, pesticides residues, livestock waste, abattoir effluents and hospital wastes.

The 1995 UK environment act defines waste as any substance or object which the holder discards or intends to discard. The act identifies different classes of waste to include household waste, industrial waste, commercial waste, clinical waste, special waste, inert waste, hazardous waste and municipal solid waste. The different types of waste to which the definition of waste applies are also set out to include:

1. Products whose dates for appropriate use have expired.

2. Materials spilled, lost, contaminated or having undergone other mishaps.

3. Materials contaminated or soiled as a result of planned action e.g. Residues from cleaning operations, packaging materials, containers, etc.

4. Unusable parts (e.g. ejected batteries, exhausted catalysts, etc.)

5. Substances which no longer perform satisfactorily (e.g. contaminated acids, contaminated solvents, exhausted tempering salts etc.)

6. Residues of industrial processes (e.g. slag, still bottoms)

7. Residues from pollution abatement processes (e.g. scrubber, sludge, dust, spent filler etc)

8. Machining or finishing residues (e.g. lathe turnings, mill scales, etc)

9. Residues from raw materials extraction and processing (e.g. mining residues, oil field slops etc.)

10. Adulterated materials (e.g. oils contaminated with PCBs etc).

11. Off specification products.

12. Any materials, substance or product whose use has been banned by law.

Wastes and effluents are indications of the inefficiency of processes. The wastes category that poses the greatest threat to the environment is the hazardous waste. Hazardous waste is defined as waste which is dangerous or difficult to keep, treat or dispose of, and which may contain substances which are corrosive, toxic, reactive, carcinogenic, infectious, irritant or harmful to human health and which may also be toxic to the environment. Hazardous wastes are difficult and expensive to treat. The chemical and primary metal industries produce the majority of the waste and 80% of the wastes generated are sludge or liquid.

The different categories of what constitutes wastes and their effect on the environment are presented below;

Solid Wastes: The indiscriminate dumping of solid waste is a daily nuisance in many urban centres in Nigeria is an understatement. As far back as the early 80s (Oluwande, 1984) reported that less than 25% of the solid wastes

generated in many developing countries (Nigeria as a special case study) is actually collected. The remaining 75% is allowed to cause nuisance and pollution of the environment.

Sewage: In Nigeria however, there is a general paucity of central sewage systems resulting in an untreated domestic wastewater, which also increases the level of pollution of the sources of fresh water. This problem can be better appreciated when considered in the light of the fact that Ibadan city, for example, became centrally sewered for the first time in 1978 (Tokun, 1979).

Industrial Wastes: In developing environments, industries especially the small scale industries are springing up at a rate which is higher than other sectors of the economy. Their spent water has to be disposed of effectively in order to minimise potential contact between people and waste. The polluting effect of industrial wastewater on Nigerian water bodies makes their use dangerous to public health.

Oil Spillage: The phenomenal growth of petroleum industries has resulted in a considerable social and economic growth in the country since about 90% of the federal revenue still comes from the sale of crude oil. However, petroleum production has generated several environmental and social problems particularly in the oil producing areas of the country. The exploratory drilling for oil on shore involves certain amounts of alteration of land surfaces. Vegetations and crops are cleared to make way for seismic lines and roads. Sites for drilling rigs are also levelled. Drilling mud and oil may also

contaminate streams, surface water and farmland due to different operational factors:

Pesticides Residues: There is a considerable market for pesticides in developing countries because of the growing population and increased pressure on land for food production. Its application pollutes water sources such as streams, ponds and wells.

Livestock Waste and Abattoir Effluent: In Nigeria,. millions of tonnes of animal wastes are produced annually. These wastes contain considerable quantities of nutrients and organic components which could be utilised.

Hospital Wastes: Hospital wastes became global priority in 1990 as a result of world concern for hazardous waste with the WHO requesting all member nations to develop safe and sound policies on hazardous waste management, with special concern for hospital waste because of the epidemic scourge of AIDS.

1.1 History of Food Processing Industries in Nigeria

Food processing in Nigeria begins with the farmer and fishermen who produce raw agricultural produce for manufacturer and processors. The food processors convert the raw materials with the aid of sophisticated equipment into many forms that are distributed to consumers.

The food industry started at cottage level until the colonial periods when the British United African Company (UAC) established another arm of the company called the Level Brothers in 1923. The companies buy cocoa,

and palm produce and groundnut, which were processed into beverages and vegetable oil by their arm.

Gradually, the ocean trawlers with cold room came fishing and freezing fishes on the later on Coca-Cola came with soft drinks. Since about two decades ago, indigenous food processing industries have taken the challenge to compete with their foreign counterparts.

Food processing in Nigeria today can be classified into 16 sub-sectors; Breweries; Starch and Miscellaneous; Food products; Soft drinks and Carbonated water; Flour and grain milling; Meat; Poultry and Fish; Tea Coffee and other Beverages; Fruits juices; Animal Feeds; Sugar Distillery and blending of spirits; Cocoa, Chocolate and Sugar Confectionery; Agro and Food Chemicals, and industrial packaging.

The sensitive nature of food and the need to ensure safety motivated the federal government to ensure safety and to establish Standard Organisation of Nigeria (SON) in 1970 to;

i. Organise tests and do everything necessary to ensure compliance with standards designated and approved by standard organisation of Nigerian council.

ii. Undertake investigations as necessary into the quality of facilities, materials and products in Nigeria and establish a quality assurance system including certification of factories, products and laboratory.

Standard Organisation of Nigeria discharges its mandate this the food and Drug Act, 1974. This is complementary with the codex alimentary commission which is an international organisation established in 1962.

Furthermore, a similar mandate nas been given to the National Agency for Food and Drug Administration and Control (NAFDAC) and Food and Drug Administration (FDA) (an arm of the federal ministry of health).

It is in the light of this that a study of solid wastes and effluents from NASCO foods Nigeria Limited (food processing industry) was considered important in order to ascertain its compliance to the set rules and regulations of the government of Nigeria.

1.2 Nasco Foods Nigeria Limited as Food Processing Industry

NASCO Foods Nigeria Limited located along No. 44 Yakubu Gowon Way Jos, Nigeria was established in 1978. It is a branch of Nasco Group of Companies. Its corporate office was commissioned by General Muhammadu Buhari (Rtd) on 11th March, 1985.

The company's philosophy is pursuit of excellence in all aspects of business operations. This is anchored around competent and well trained staff spread about its many departments.

Nasco Foods Nigeria Ltd is into production of foods such as wafers, Nice, Cornflakes, Tea Bags, Cream Crackers, Biscuits (Orange flavours, shortcake, chocolate cream, strawberry etc.)

The company has four main departments each with its own specifc functions. Administration/Personnel, production, accounting and technical quality control department.

Administration/Personnel: This is the organisation and direction of persons in order to accomplish a specified end, a predetermined purpose, goal, aims and objectives. Furthermore, it has the capacity of coordinating many and often conflicting social energies in a single organisation so that they shall operate as a unit. It is concerned with planning, co-ordination, supervision and control of company's enterprise. It is the process on which social stability rests. The proceses of organisation and management constitutes administration.

The major function of organisation is staffing and organistion in the company. **Staffing** involves devicing an efficient and effective system of staff recruitment, training and providing favourable conditions of work. **Organising** here is a means of achieving the best result from concerted efforts. Organising is the setting out of the formal structure of authority and flow of work in such a way that the work in the various sub divisions is carefully arranged, clearly redefined and effectively coordinated in order the accomplish the objectives of the organisation.

Accounting: The account section constitutes the financial framework of the company. This section help to p'ill savings, excess liquidity, salary scaling/bonuses and financial status of the company. It keeps such records as

cost of production from inputs, profit maximised from output, prizes of commodities produced etc This is the all-importtant function of keeping the staff and all the stake holders informed of what is going on. This is usually done through records or documents research, supervision, bulletins, notice boards etc.

Production Department: it monitors and keeps records of all combined factors of production used in the company. In the production stream, quality and quantity of product are checked and compared to standards, to avoid rejection by consumers. It also entails continually ensuring that various branches of the organisation are working smoothly, that the interrelated tasks being performed in the various sub-divisions and sections of the organisation are harmoniously co-ordinated.

Technical/quality Control departments.

In all manufactured products no two objects are exactly the same. Quality control in the traditional sense involves the statistical sampling of a component as it is produced or delivered by a supplier. The normal distribution curve is often used as a basis for the statistical sampling of production run of a component. The tolerances.

1.2.1 Breakdown of Nasco Groups Productions:

1.2.1.1 Nasco Fibre Productions

Carpets, Cordex, Velour, Super Tiles, Cup Coaster,Peugeot Car Seat, Plain Board.

1.2.1.2 Nasco Pack Limited

Orange Tea Bag, City Tea Bag, Highland Tea Bag, Mint, Lantana Kilishi (Natural prime Beef) Cornflakes, Standard Sweet Cabin Biscuits, Wafers, Sofia, Crown Cubes Sugar, Solin cough syrup, Action detergent soap

1.2.1.3 Nasco Confectionery

Bubble gum, Jelly, Apple banana, Chichi sweet

1.2.1.4 Nasco House Hold Products

Brytex detergent, Shampoo, Slash bar soap, toilet soap, gel

1.2.1.5 Nasco Foods

Nice biscuits, custard cream biscuits, chocolate cream biscuits strawberry, Wafers, cornflakes, Tea time, Cream crackers

1.3 Statement Of Problem

Nasco Foods wastes contributes to the increasing industrial problems. Improper disposal constitutes a nuisance to the environment. The block drainage can also destroy aquatic life. Some of the pollutants are readily biodegradable while some take a long time before they decompose.

The continuos discharge of untreated industrial effluents, laden with lethally toxic chemicals such as lead, mercury, cadmium and persistent organic such as DDT, into drains and surface water exacerbated by improper sewage disposal have rendered most of the sources of water milky, coloured, odoriferous and unwholesome for any beneficial use by man.

It is all these factors that led to the study of qualitative and quantitative analyses of wastes generated from Nasco Foods Nigreia Limited. Information obtained from this study will be used to design efficient end –use treatments and mitigation measures towards the impact of wastes on the Nigeria environments.

1.4 Objectives Of Study

The objectives of this study are to analyse the amount of waste generated by Nasco Foods Nig. Ltd and to determine the quality in terms of compliance to the national and international regulations concerning wastes. It is further to determine the nutritional content, physical, organic and inorganic properties of the wastes. From the results expected, it is hoped that deductions and recommendations could be made on how the waste could be utilised and treated to ensure a friendly food industrial environment in Nigeria. The objectives can be summarised below:To determine the amount of waste generated from Nasco Foods Nigeria Limited

1. To evaluate the quality of the waste generated from Nasco Foods Nigeria Limited (both solid and liquid wastes).

2. To study the present end-use of the waste in order to recommend other uses to which the waste can be put and to examine the necessary treatment to be given to the generated waste.

3. To assess compliance with regulatory bodies, rules and standards for waste composition.

1.5 Justification of Study

There are many uses to which food waste can be put. In a developing country like Nigeria, food waste contributes to the industrial waste problems. Improper disposal constitutes nuisance to the environment, destruction of drainages, shores and recreational facilities. Streams and rivers are being polluted by the untreated waste discharged into it. While the waste can equally decompose and degenerate into a contagious disease spreading site due to the presence of pathogenic agents in it. Furthermore, there is considerable variation from process plants in the amount of water used and the waste generated.

In general, wastes from these industries contain oil and grease, and may be of high or low PH. Normally, these wastewater contain no hazardous or toxic materials. Occasionally, wastewater containing high concentration of sodium chloride may be discharged.

Under normal operations, gaseous emissions are not a problem. Solid waste, if not recovered could present a treatment and disposal problem. Fortunately, newer plants recover more solid waste by screening or dry collection. These wastes are further processed as fish meal, concentrated protein soluble, oils, liquid fertilizers, fish food pellets, animal feed. (vital feed company).

1.6 Scope and Limitations of the Study

This project is to carry out quantitative and qualitative study of the waste (solid and liquid) generated from Nasco Foods Nigeria Limited The result of this work will enumerate the uses, treatments and environmental impact of the waste.

The limitations of this project are:

The work stops on the waste generated from Nasco Foods Nigeria Limited

The food section of Nasco Groups was used as a case study.

The work does not include assessment of toxicological nature as well as pathological nature of the waste, because of the limited available analytical facilities.

CHAPTER TWO

LITERATURE REVIEW

2.1 Food Processing

Food processing involves the processing and packaging of meat and meat products, fish and shell fish, diary products, fruits and vegetables, grains and beverage production. Food processing may include refinement, preservation, product improvement, storage and handling, packaging and canning.

The basic raw materials of the industry are either naturally produced or grown. The processing may involve receiving and storing raw or partially processed plants or animals or other food materials, processing the materials into finished products, and packaging and storing the finished products.

2.2 Production Processes

Nasco Foods Nigeria Limited Use the following production processes in the manufacture of biscuits, crackers, wafers, cookies, confectioneries etc.

2.2.1 Wafer biscuit production

Wafer are baked as sheets cones and sticks or with different fancy shapes. They are two basic types:

1. Low-sugar wafers. The finished biscuits contain from zero to a low percentage of sucrose or other sugars. Typical products are flat and hollow wafer sheets, moulded cones, and fancy shapes.
2. High-sugar wafers. More than 10% of sucrose or other sugars are responsible for the plasticity of the freshly baked sheets. They can be formed into different shape before sugar recrystallization occurs. Typical products are moulded and rolled sugar cones, rolled wafer sticks , and deep-formed fancy shapes.

In both wafer types, the main ingredient is usually wheat flour.

Table 2.1: Wafer biscuit ingredient ranges (weight parts; flour = 100)

	No(Low)-sugar	High-sugar
Wheat flour	100	100
Water	130-160	100-140
Sucrose	0-4	25-70
Milk powder	0-2	0-2
Oil or fat	0.5-2	2-6
Soya lecithin	0.2-1	0.2-1.5
Sodium bicarbonate	0.1-0.5	0-0.3
Salt	0-0.6	0-0.6

Table 2.2: Typical production schemes for two of the currently most important products of Wafer biscuits

	No-sugar wafer (e.g sandwiched wafer biscuits)	**High-sugar wafer (e.g rolled sugar cone)**
	step	
1.	ingredient mixing	ingredient mixing
2.	Batter transport and depositing	Batter transport and depositing
3.	oven baking of a sheet	Oven baking of a sheet
4.	Release and cooling	Release and forming
5.	Conditioning	cooling
6.	Creaming and book building	stacking
7.	cooling and cutting	Packaging
8.	Enrobing or moulding	
9.	cooling	
10.	Packaging	

Ingredient mixing (Fig. 1 process 1)

After mixing for a few minutes, the water-soluble component are dissolved and the farinaceous ingredients made up into a homogenous suspension (wafer batter)

Batter Transport and depositing (Fig. 1 process 2)

From a storage tank, the batter is pumped to a depositor head and spread onto the baking mould:

Oven Baking (Fig. 1 process 3)

The baking of water sheet is performed in 'Tongs', that is, pair of cast-iron metal plates with a hinge and latch on opposite (shorter) sides. The precisely machined baking plates carry readings or other engraving (Flat' wafer sheet). The plate can also carry special figures (nut. Sticks hemisphere, fancy shapes) up to s depth of approximately 20mm. This kind

of sheets are called "hollow wafer" they can be gas or electrically heated and operate at temperature between 160^{0}C and 180^{0}C.

Release and cooling (Fig. 1 process 4)

At one end of the oven, the plate open to release the baked sheets and spread fresh batter, and then reclose very quickly. The sheets are cooled to room temperature while passing through an arch-type sheet cooler.

Conditioning (Fig. 1 process 5)

After baking, the water content is below 1%, for this reason wafer absorb humidity very easily. Parallel to water uptake, the dimensions of the sheet increase by approximately 0.2% for every 1% of additional water. 70 compensate for the low water activity, humidity conditioning up to 3% or 4% water content is possible.

Creaming and book building (Fig. 1 process 6)

The sheets then pass the creaming station, where a cream layer is applied to one side sugar and fat with different flavours (hazelnut, chocolate, caramel, milk, fruit) at temperature of 30-40^{0}C are used. Several creamed sheets, together with creamed top sheet, form a so-called 'wafer book'.

Cooling and cutting (Fig. 1 process 7)

The cooled wafer books are wire-or saw-cut into small biscuits

Enrobing or moulding and cooling (Fig.1 processes 8 and 9)

The cut biscuits may be enrobed with chocolate sometimes after the application of chopped nuts or crispies to the top wafer. Moulding in chocolate is another possibility. After a final cooling step, the biscuits are ready for packaging the biscuits have to be packed tightly to protect against humidity, and also against oxygen and light, to ensure a shelf life of 6-9 months.

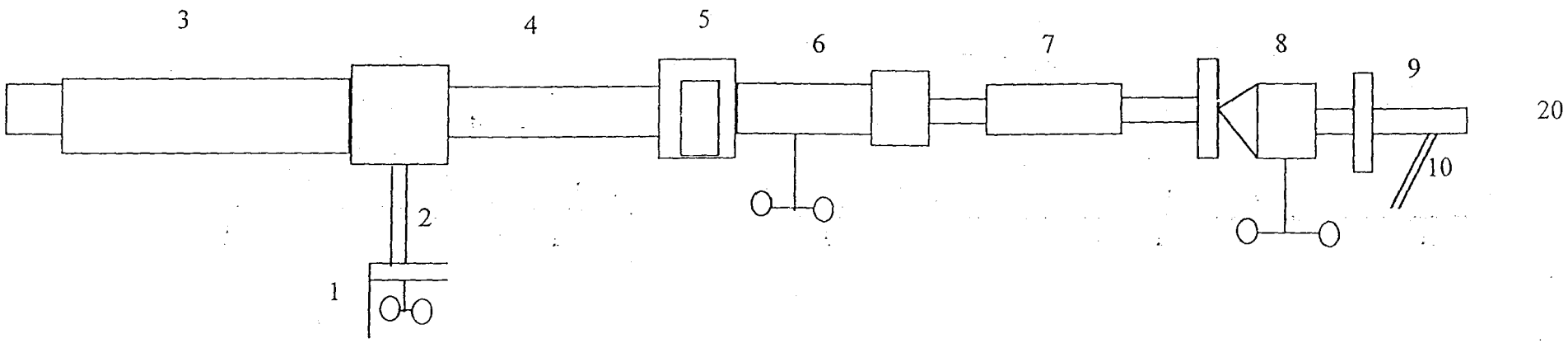

Fig2.1 Wafer Biscuit Production Processes from Nasco Foods Nigeria Limited

2.3 Some Products produced by Nasco Foods

2.3.1 Cream Crackers

Cream crackers originated in the 1980s from an Irish firm named Jacobs. They are popular in the UK. Although the product name implies that there is cream in the product, there is none. It seems that the name is traditional with no reference to the ingredients utilised to make the product. The cracker is similar to a soda cracker in that it is created from an unsweetened but long-fermented laminated dough.

2.3.2 Snack Crackers

The biscuits comprising this group are colloquially called "hard dough" biscuits. They originate from the UK. All dough of these products are characterised by a well-developed glutein network which is the result of a relatively high water content, relatively low amount of fat and sugar, and vigorous mixing. The unusual formula is quite simple, containing only flour, sugar, shortening, molasses or corn syrup, chemical leavening and water. The sugar content is usually 18 – 20% of the flour weight for the semi-sweet biscuits. In hard or semi-hard biscuits the shortening is present in about the same proportion as the sugar. Corn syrup or molasses is present at 8 – 9% while water varies up to 20% of the flour weight.

2.3.3 Rotary Cookies

Rotary cookies are thin and smooth with no cracks or irregularities in the surface. The formulation must be controlled so that the product does not change shape during baking, causing the design to blur or distort. Thus, a formulation on which there is essentially no spread, no lift or flow of the dough is desired. Dough that meets these requirements is generally high in shortening and sugar, and low in moisture. Ingredients that would contribute moisture and provide means for either glutein development or encourage dimensional change such as water, milk, syrups and eggs are limited. The only other ingredients included are flavours, colours and chemical liveners.

2.4 Food Processing Wastes

The generation of wastes can be said to be an inevitable fact or living. Continuing advancement in science and technology is contributing significantly to the increased volume and toxicity of wastes generated. Developing countries (including Nigeria) are not left out of this earths threatening problem. All forms of wastes such as municipal solid waste and wastewater, household wastes, radioactive wastes, and other hazardous wastes continue to find their way into the waste stream. This is no doubt, constitute a threat to the nation's environment.

Food processing wastes are in solid, liquid and gaseous states. The chemicals used are highly soluble in water and their presence in the effluent

even at minimal levels constitute a nuisance to the water. Generally, the results and observations of this study show that the organic strength of most industrial effluents is high enough to cause a remarkable alteration of the natural equilibrium of receiving water courses.

2.4.1 Waste at Nasco Foods

The major wastes from Nasco Foods are:

2.4.1.1 Solid wastes;

The solid water originate from the following sources

1. Deposition of unused biscuit wafer and cornflakes wrappers
2. Deposition of unused of cornflake carton
3. Reducing or increasing the size of the biscuits
4. Unlabelled cornflakes wrapper
5. Unlabelled refiller, seasoning wrapper

2.4.1.2 Liquid wastes: These result from water used for production, generation of stream, cleaning of the floor. Nasco Foods disposes large volume of waste water derived from various manufacturing operations into the flowing stream. The liquid wastes are pollutants being rich in dissolved and suspended substances such as nitrogenous substances. Sugar residues of seasoning etc. inorganic chemicals such as caustic soda hypochlorites and peroxides, soap and detergents used for washing and sterilizing of equipment are also present in the effluent.

2.4.1.3 Gaseous wastes: Atmosphere pollution from engines consists of unburst hydrocarbon, oxides of nitrogen and carbon. Exhaust gases can be dangerous concentrations of one percent of carbon monoxide in air are rapidly fatal.

2.5 Waste management in Nigeria

Wastes management involves the collection, transportation, storage, treatment and disposal of wastes including the after care of the disposal sites.

Disposal involves the storage, tipping of deposit on or below the ground as well as all the transformation operations utilised for waste recovery, re-use or recycling. (Adegoke, 1992). Thus, the best option in waste management is a no waste technology approach (zero option), that is no waste is generated. This represents an ideal against which any other waste management options must be assessed. This is directly followed by waste minimisation and the last option is waste treatment.

Waste minimisation is mandatory for existing industries to eliminate and/or minimise waste being generated from their production process. Proper waste analysis at the design stage is therefore imperative. Industry should look for the processes where there is no waste, and where that is impossible, they should practise waste minimisation where the quantity of wastes, whether harmless or not, should be reduced to barest minimum. This is because waste, even when non-polluting, results in the depletion of the earths

resources including the energy requirements for processing. Waste recycling in mandatory for waste minimisation (Susu, 1995).

The increasing demand for environmental protection through regulated environmental standard should force industries in Nigeria to re-evaluate the economic impacts of environment al issues and adapt new and cost effective approaches to waste management. Management must adopt new attitudes about waste and environmental problems. Waste reduction within the manufacturing process reduces costs and cost savings arise with saving in for example energy costs, waste storage space, transport costs, administrative costs and lower emissions to air, water and on to land. Reducing waste in the production process in industry can also reduce the amount of raw materials inputs in addition to final disposal costs.

The techniques to waste reduction is illustrated in figure 2.1.

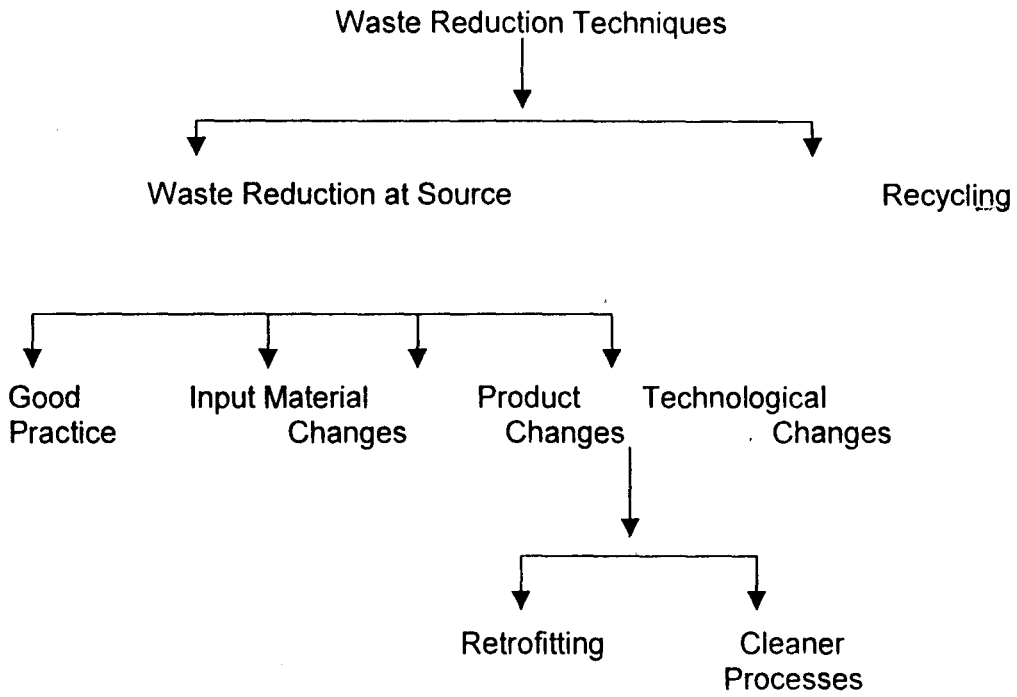

Fig. 2.1: Techniques for Waste Reduction
Source: Williams, P.T. (1988)

Good practice may involve simple and effective acts of good house-keeping, following production procedures, minimizing spillages and proper auditing of input and final destination of raw materials.

2.5.1 Establishing a manufacturing process waste reduction program

The establishment of a process waste minimization programme requires undertaking a number of important steps, which include;

(a) **Recognition and acceptance of a waste management problem;** First accept the implications of a waste stream and obtain commitment and support of senior management for the waste assessment to initiate the programme. The following activities are required for programme initiation.

i. Issue policy statement on waste reduction

ii. Define goals and time scales for the assessment

iii. Nominate Assessment team leader and member. Team members should have experience in the following areas;

1. Industrial operations to be assessed.
2. Knowledge of applicable waste and environmental regulations
3. Understanding of potential waste minimization alternatives
4. Ability to make technical and economic appraisals of waste minimization alternatives.

b. **Data Collection:** Comprehensive information on waste streams, processes, raw materials, production schedules, operating costs, environmental reports permits and company policies should be obtained.

Table 2.1: Typical Areas Of Expertise For Waste Assessment

Areas of Expertise	Information Required
Design and Process Engineering Production and Maintenance Environmental Legal Accounting, Finance and Purchasing Health and Safety Research and Development Operations, Supervisors, Transport Department	Plant and Process Impact Process Descriptions and Operating Details Regulations Treatment Systems Environmental Liability Costs and Inventory Controls Hazards and Risks Technical options of modifications Operational Suggestions. (Assess, Operational and Procedural Suggestions for changes).

c. **Waste Audit:** The Audit phase involves actual site investigations to confirm information and provide a detailed and practical understanding of how and where the waste streams are generated. According to Harrison (1999), this phase is accomplished in four major steps;

1. Site investigation
2. Construction of Process flow diagram
3. Definition of process inputs and outputs
4. Material balance.

d. **Identification of Waste Reduction Alternatives:** Identify waste reduction alternatives from information obtained from the waste audit and the practical observations of plant units.

e. **Prioritization of waste reduction alternative:** Evaluate and screen the waste reduction alternatives identified from the audit and prioritize them in relation to the assessment objectives and other selected criteria such as cost and ease of implementation.

f. **Feasibility Analysis:** The waste reduction alternatives are evaluated in terms of technical and economic feasibility depending on available time and resources for implementation. While technical analysis consider criteria such as safety, product quality, compatibility with existing production, labour requirements and environmental effects, economic evaluation involves a cost/benefit analysis.

g. **Waste reduction assessment report:** A close up report on the waste reduction assessment is prepared and submitted to top management for evaluation.

2.6 Treatment of Industrial Wastes

Industrial wastes control has become a cost factor of considerable concern in manufacturing industries. The stringent waste control regulation and the compelling need for compliance are increasing "end-of-pipe waste management costs".

Wastes exist in solid, liquid and gaseous forms, which needs prompt treatment before disposal. Wastewater is the combination of the liquid or water carrying waste from residences, institutions, commercial and industrial establishments including groundwater, surface water and storm water where present Wastewater should be treated before the ultimate disposal into a receiving water course to prevent the spread of communicable diseases. (Metalf and Eddy, 1974).

It is therefore imperative that developing countries should evolve a simple, efficient and relatively to sewage treatment system. According to Burgess (1973). There are two fundamental requirements of any acceptable disposal technique. First, the method must be safe and secondly, it must be economical. The practice of ocean dumping was initiated in 1887 in the United Kingdom with the dumping of London waste in outer Thames estuary. In the United States, the first dumping of sewage occurred in 1924 in the then New York bight. In early 1970, there began a growing interest both nationally and internationally in marine pollution (champ and Park, 1981). Consequently, the

United Kingdom decided to phase out the disposal of the sewage sludge to sea by 1998. Now the sewage sludge is being used as forest fertilizer (Wolsten, 1993). This serves to enrich soil nutrients and improves crop yield.

2.6.1 Methods of waste treatment

There are three basic methods of waste treatment;

2.6.1.1 ***Primary (Physical) Method***: This method prepares the wastewater for biological treatment. Large solids are removed by screening and pit is allowed to settle down. Equalization, in a mixing basin level out the hour to hour variations in flows and concentration. There is a spill bond; to retain slug of concentrated wastes that could upset the downstream processes. Oils, greases and suspended solids are removed by floatation; sedimentation (removal of solids by gravity in a stabilization pond) and filtration. Mechanical flocculation removes fine particles from solution. Mechanical filtration makes use of screen to separate suspended solids. Evaporation is also adopted to reduce water content so as to concentrate the particulate substances. Adsorption removes soluble impurities from the wastewater. (Eckenfelder, 1989).

2.6.1.2 ***Chemical Method***: This method involves the application of chemicals to the wastewater in order to remove and coagulate the dissolved solids, to reduce the toxicity level of the wastewater and adjustment of the pH. Adjustment of pH is achieved by Neutralization with either an acid or lime. The addition of oxygen serves to aerate and initiate aerobic process of degradation of the wastewater.

Chlorinating of the wastewater oxidizes heavy contaminants like cyanide.

Metal hydroxide is precipitated by addition of lime.

Chemical flocculation which removes fine particles is accomplished by addition of Aluminum sulphate (Eckenfelder, 1989).

2.6.1.3 ***Biological (Secondary) Method:*** This is the biological degradation of soluble organic compounds from input concentration of 50 to 1,000 mg/l and its reduction to typical effluent levels under 15mg/l. (Eckenfelder, 1989). An aerobic or anaerobic digestion process achieves the biological degradation of the waste.

Aerobic Process: It is otherwise referred to as aerated lagoon, which is just a basin of depth (2.4m to 4.9m). The process requires sufficient oxygen for aerobic bacteria to convert the waste thereby breaking it into simpler and disposable forms. In aerobic lagoons, which have powered level of 2.8 to 3.9w/m^3. this, differentiate it from the facultative lagoon, which has a power level, that is less than 2.8w/m^3.

Anaerobic Process: This is typical of the reaction in close sewers. It takes place in a low-level oxygen atmosphere. Anaerobic microorganism or bacteria

digest the waste into simpler forms. It is often accompanied by irritating smell. The biological process primarily forms organic acid, which was followed by fermentation.

2.7 Waste Utilization

The background policy of waste minimization is waste re-use. One very significant way to conserve water resource is to re-use industrial and municipal effluents. According to Osuji et al (1988), out of an estimated 40million litres of available water from pharmaceutical companies and brewing companies liquid effluents, only 25% or about 10million litres is re-used.

The re-use of waste within an industry is often practised as a means of minimizing water charges, the most common application being the re-use of others. The industrial water use of some companies are illustrated in tables 2.2.

Table 2.2: **Industrial Water use and wastewater Discharge for some Industries in Nigeria**

Industries	Mean Water Usage ($x10^3$lit/day)	Mean Water Usage ($x10^3$lit/day)
Foods and Beverages	1,000	650
Soft Drinks	35,000	23,000
Nigeria Breweries	400	160
Paint	3,790	947
Automobile Battery	200	100

Source: Kumapayi, 1994.

Wastewater can be used as irrigation water when the composition is adjudged suitable for crop growth. It can also serve for ground water re-charge and other industrial uses such as crawling a heating process at the other end and flushing deposited sludge from conveyances.

CHAPTER THREE

METHODOLOGY

3.1 Design of the Study

This study design was based on Investigative Survey Research Approach [ISRA] (Chukwu, 1994). The ISRA for obtaining data will entail the schedule of visits to Nasco Foods Nigeria Limited. The tasks that would be accomplished during such visits would include the following:

A. Administering and completion of structured questionnaires from available records kept by the industry.

B. Interviewing relevant and competent staff of the industry.

C. Inspection and witnessing processing operations.

D. Taking relevant measurements.

E. Collection of effluents and solid wastes for laboratory analyses.

Two types of data would be sought for in industry. They will be qualitative and quantitative in nature based on:

a. Observation

b. Measurements

c. Computations

d. Existing records

e. Information from structured questionnaires

3.2 Description of the Questionnaire

The Questionnaire for this study will contain the general information on the Food Processing Industry. Questions are structured so as to elicit information on the quantitative and qualitative aspects of the wastes generated by Nasco Foods Nigeria Limited.

3.3 Quantitative and Qualitative Analyses of the Industrial Wastes

An important aspect of the assessment of environmental impacts of food processing industries is the quantitative/qualitative analyses of the industrial waste(s). Questionnaires will be administered to collect the desired information and measurement of discharges would be carried out to estimate the quantities of wastes generated. The qualitative assessment will be carried out in relevant laboratories.

For quantitative measurements, the quantity of waste generated will be estimated through the measurement of discharge ports and the rates and duration of discharge. The rate of discharge and the size of discharge orifices will be taken. When the time and the rate of discharge are known, the quantity discharged can be determined. Containers will be used to collect the samples over time. The exercise will be done in three replicates for several operations at specified intervals (Ojo, 1998; Chukwu, 2003).

For the quantitative measurements, the samples that would be collected will be sealed in polythene bags, frozen immediately to prevent deterioration and taken to the laboratory for analysis. The Association of Official Analytical Chemists (AOAC) nutritional guidelines will be used for the

nutritional analyses. The pH test and tests for other parameters will be conducted using standard chemical methods.

The following nutritional assessment will be carried out on the solid waste (Chukwu, 2003):

a. Moisture content (%)

b. Dry Matter content (%)

c. Lipid content (%)

d. Crude Protein content (%)

e. Carbohydrate content (%)

f. Ash content (%)

g. Crude fibre content (%)

Also, the following physical, chemical and organic assessments would be carried out on the effluents (liquid wastes) (Chukwu, 2003).

A. (1) Temperature (^{o}C)

(2) pH

(3) Turbidity (NTU)

(4) Conductivity (µs/cm)

(5) Total solids (mg/ℓ)

(6) Total dissolved solids (TDS) (mg/ℓ)

(7) Oil in water (ppm)

B. Chemical Parameters (mg/ℓ)

(i) Sulphates (SO_4^{2-})

(ii) Reactive Phosphates (PO_4^{3-})

(iii) Sulphides (SO^{2-})

(iv) Chromium (Cr^{6+})

(v) Chlorides (Cl^-)

(vi) Total iron (Fe)

(vii) Copper (Cu)

(viii) Nitrates (NO_3^-)

(ix) Nitrites (NO_2^-)

(x) Alkalinity

(xi) Chlorine (Cl_2)

C. Organic Parameters (mg/ℓ)

(a) Chemical Oxygen Demand (COD)

(b) Biochemical Oxygen Demand (BOD)

(c) Dissolved Oxygen (DO)

3.4 Method of Analyses

This section contains the methods of analyses. The analysed data were sourced from observations, measurements, computations, existing records, information from structured questionnaires and collection of wastes.

3.4.1 Solid and Liquid Wastes

The analyses of the wastes will be done using Bar charts, Pie charts, Component bar chart, Arithmetic mean and standard deviations.

3.5 Properties of Wastes to be considered

This is based on the method adopted by Chukwu (2003).

A. Quantity of Waste generated

The discharge ports, circular or rectangular as the case may be, will be measured in order to know their areas and the amount of waste discharged per unit time.

(i) From the overhead discharge port, a 2.0kg metallic container will be used to collect the solid waste as it drops from the discharge port for 60 seconds. Three replicate samples will be taken at different days and the average calculated.

$$\text{Rate of discharge} = \frac{\text{Mass discharged}}{\text{Time taken}} \text{ (kg/s)}$$

(ii) For the effluent (liquid waste), a 1500 ml container will be placed at the discharge port for 10 seconds and the volume collected noted. This measurement will be taken thrice at different days.

$$\text{Rate of flow} = \frac{\text{Volume discharged}}{\text{Time taken}} \text{ (m}^3\text{/s)}$$

B. Nutritional Constituents of the solid waste

C. Physical, chemical and organic parameters of the effluent (liquid waste)

3.6 Sampling Technique/Procedure

The objective of sampling is to remove a small portion of the solid waste or an effluent stream that is representative of the entire solid waste or effluent. The sampling location (site) is: Nasco Foods Nigeria Limited, Old Bukuru, Jos, Plateau State.

For the solid waste, 3 samples of 500g each will be collected from the metallic container every 2 hours. This will be done for 3 days using a 600g polythene container. These add up to 6 samples for the site.

For the liquid waste (effluent), 3 samples of the waste will also be collected at 2 hourly intervals. This will be done also for 3 days at the discharge port using a 400 ml plastic bottle. These add up to 6 samples for the site.

The solid waste and effluent samples will be carefully collected, labelled and sent to the analytical laboratory for analysis.

3.7 Determination of the Quality Characteristics of the Waste

3.7.1 Solid Waste

The determination is usually made on dry samples except for moisture content determination. The material will be dried at room temperature by exposure to solar energy. It will then be ground in a mortar into powdered form and passed through a sieve of 20 mesh size and then stored in dry containers at room temperature. The AOAC nutritional guidelines will be followed for the nutritional analyses.

(a) **Moisture Content (MC)**: This is the quantity of water in a mass of a material, expressed in percent (%). The standard procedure that will be used is the Vacuum Oven method:

Apparatus:

Vacuum Oven

Balance (electric balance, 0.01g sensitivity)

Metal dishes with tightly fitting covers

Dessicator

Mill/Mortar and pestle/blender

Method:

A covered metallic dish will be dried in the vacuum oven at 102 $\pm$3°C for 20 minutes, then cooled in a dessicator and weighed (W_1). A mass of 10g of the sample will be put into the dish and weighed (W_2). The dish with the sample will then be dried in an oven at 102$\pm$3°C for 24 hours (to ensure constant dryness and mass). This will be transferred into the dessicator to cool and then weighed with minimum exposure to the atmosphere (W_3). The loss in weight per unit weight of the sample during drying is the MC wet basis (MC_{wb}, %).

$$MC_{wb}\ (\%) = \frac{W_2 - W_3}{W_1} \times 100 \text{ ----------3.1}$$

(b) Dry **Matter (DM)**: The DM is the material left after the "free and bound" water has been removed from a sample. The dry matter can also be defined as the ratio of the dry weight to the wet weight of a material, expressed in percent. The vacuum oven method will be used as it has the advantage of lower drying temperatures which decrease the decomposition of the dry matter.

About 10g of the dry sample will be taken and placed into the dry dish (prepared as above) and weighed (W_2), so that the weight of the sample will be ($W_2 - W_1$). The dish with sample inside will be heated in an oven to a temperature of 100°C for 2 – 3 hours. The residue will then be weighed in the crucible dish (W_3).

$$DM\ (\%) = \frac{W_2 - W_3}{W_2 - W_1} \times 100 = \frac{\text{dry weight}}{\text{wet weight}} \times 100 \quad \text{----------3.2}$$

(c) **Lipid Content (LC)**: Lipids are a group of naturally-occurring compounds which are characterized by their insolubility in water (fatty acids) and solubility in organic solvents (glycerol). The unsaturated fatty acid is of utmost importance because of its high energy yield and because it serves for heat insulation. A small quantity is required in animals.

Reagent: Petroleum spirit

Apparatus: Balance

Watch glass

Round bottomed flask

Oven

Dessicator

Soxhlet extractor

Whatman extraction thimble

Paper clip

Funnels

Cotton wool

Method:- The LC will be determined by extracting the solid waste using a suitable lipid solvent such as petroleum spirit at 60°C or diethylether in a continuous extractor, such as Soxhlet type. In the extractor, non-lipids such as carbohydrates, salts and amino acids are extracted to give the proportion of free fat.

Solid waste of mass 10g will be put into a thimble of known weight (W_1). The thimble and content will be weighed (W_2). The thimble with sample will be placed inside the soxhlet extractor. 300ml of acetone-ethanol mixture (1:1) will be poured into a 500ml round joint flask. The solvent will be heated to boiling and this will continue for 24 hours before the thimble content will be removed and dried at 50°C in an oven for 24 hours. After oven-drying, the thimble content will be cooled and weighed (W_3).

$$LC\ (\%) = \frac{W_2 - W_3}{W_2 - W_1} \times 100 = \frac{\text{weight of Extract}}{\text{weight of Sample}} \times 100 \quad \text{---------- 3.3}$$

(d) **Crude Protein (CP)**: This is the raw protein content of the solid waste which constitute a major class of food useful in building and repair of the cells of the body. It is a complex block of component units of amino acids. The method is called the Micro-Kjeldahl Determination.

Reagents: Caustic soda (NaOH) solution (70g/100ml)

Hydrochloric acid (O.I N), HCl

Concentrated Sulphuric acid, H_2SO_4

Bromocresol green (0.1% alcoholic)

Methyl red (1% alcoholic)

Boric acid (4% solution)

Selenium catalyst tablets (BDH 1g Na_2SO_4 – 0.05, se)

Silicon DC Antifoam Ms A compound

Apparatus: Micro-kjeldahl flask

Mark-ham still

Balance

Pipettes

Graduated cylinders

Conical flasks

Burettes

Method: Solid waste of mass 1g will be weighed into a micro-kjeldahl flask (50ml size). 3ml of conc. H_2SO_4 will be added with 1 catalyst tablet and three glass balls. The flask will be heated on a mantle, slowly to prevent splashing until the digest becomes clear. When the liquid becomes a pale straw colour, the flask will be heated for a further hour.

The digest will be allowed to cool and then washed into the Mark-ham still using a small amount of distilled water. The flask will be rinsed a few times and the rinse added to the diluted digest. The condenser will be immersed in 10ml of boric acid contained in a conical flask (with 5 drops of bromocresol green and one drop of methyl red present). 15ml of caustic soda solution will be slowly added to the digest and the latter will be left to undergo steam distillation for 1.5 minutes after all the caustic soda has been added.

The solution in the conical flask will then be titrated against 0.1N hydrochloric acid (V_1 ml) (the end point will be reached when the solution becomes orange in colour). A blank test will be conducted following the above procedure but no digest will be added. The volume of the 0.1N HCl required for the blank test will be recorded as V_2(ml).

$$\% \text{ Total Nitrogen} = \frac{(V_1-V_2) \times N \times 1.4}{W} \quad \text{---------- 3.4}$$

$$\% \text{ Crude Protein} = 6.25 \times \% \text{ Nitrogen} \quad \text{---------- 3.5}$$

where: N = Normality of HCl

W = Weight of the test sample (solid waste)

6.25 = a factor

(e) **Carbohydrate (CHO):** Carbohydrates are essentially energy foods. If the total protein and lipid content are subtracted from organic matter content, the remainder accounts for carbohydrates and nucleic acid.

.. Carbohydrate (%) = organic matter (100%) – (Protein (%) + Lipids (%))

(f) **Ash Content (AC):** This is the organic residue from the incineration of organic matter. Its content and composition depend on the nature of the food ignited and the method of ashing.

Reagents: Olive oil

Distilled water

Apparatus: Oven

Dessicator

Silica/platinum dish

Balance

Bunsen burner

Muffle furnace

Method: A silica or platinum dish will be dried in an oven at about 105°C to constant weight (W_1). The dish will be left to cool in a dessicator. 10g of solid waste will be added to the dish and then re-weighed (W_2). A few drops of olive oil will be added to the dish. The dish will then be heated gently over a

burner flame. When the sample stops bubbling and smoking, it will be heated further until it becomes well carbonized.

The dish will then be placed into a muffle furnace at about 525°C for 2-3 hours. It will be removed and allowed to cool and some distilled water will be added to the sample. The water will be evaporated over a steam bath and the sample dried on a hot plate. After this, the dish will be placed back in the muffle furnace until white ash is obtained, after a further 3-4 hours. The dish will then be placed into a vacuum dessicator to cool and then weighed again (W_3).

$$AC\ \% = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \quad \text{----------} \quad 3.6$$

(g) **Crude Fibre (CF):** This represents the fat-free component of the solid waste. The fat-free sample will be obtained by adding 4 vols of ethyl alcohol which will precipitate soluble dietary (crude) fibre.

5g of dried fat-free sample will be weighed into a beaker (W_1). 200ml of H_2SO_4 will be added and the beaker is to be placed under the condenser and brought to boiling within 60 seconds. Boiling will be allowed to continue for 30 minutes and distilled water will be used to maintain volume and to wash down particles that will adhere to the sides of the beaker. This will then be filtered and using suction the residue will be transferred back to the beaker. 200ml hot NaOH solution will then be added. This will be replaced under the condenser and again brought to boiling within 60 seconds.

After boiling for 30 minutes it will then be filtered through a porous crucible and washed with boiling water, then 1% HCl and boiling water again. Further washing will be done twice, using alcohol. The sample will then be

dried overnight at 100°C, cooled and weighed (W_2). It will then be ashed at 500°C for 3 hours, cooled and weighed (W_3).

$$CF\ (\%) = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \quad \text{---------- 3.7}$$

3.7.2 Liquid Wastes (Effluents)

The composition of the liquid waste will be evaluated experimentally in order to determine the physical, the organic and chemical constituents of the effluent.

(i) **pH:** pH of an aqueous solution is a measure of its acidity or alkalinity. The pH test will be done using the colorimeter indicator method/pH Lovibond comparator. The following indicators will be used: Bromothymol blue, phenol red and methyl red.

During the test, 10ml of liquid waste sample will be put inside a pH comparator cell and 10 drops of indicator will be added, shaken and reviewed in pH Lovibond comparator with colour disc.

Values between 6.8 – 7.4 are termed Alkaline

Values between 4.4 – 6.0 are termed Acidic

Values at 6.0 are termed Neutral.

(ii) **Turbidity:** Light scattering turbid meter will be used for the measurement. The unit of measurement is NTU.

(iii) **Conductivity:** A conductivity meter will be used to determine the conductivity of the effluent samples in $ECX10^{-4}$.

(iv) **Alkalinity:** This will be determined by carrying out 2 tests, which are titrable alkalinity and separately determining the amount of carbonates present in the water while the other is titrable alkalinity complete which determines both carbonate and hydrogen carbonates.

Reagents and chemicals: 0.1M Hydrochloric acid

1% Phenolphthalein

1% Methyl orange

Procedure: 100ml of liquid waste sample will be pipetted into a 250ml conical flask. 2 drops of phenolphthalein will be added and titrated with 0.1M HCl to colourless. Originally the colour will be red.

$$T_A = \frac{V_A \times 100}{V_S} \quad \text{---------- 3.8}$$

Where: T_A = Titrable alkalinity

V_A = Volume of acid (HCl)

V_S = Volume of sample which will be 50ml

$$T_AC = \frac{V_A \times 100}{50} \text{ mg/}\ell \quad \text{---------- 3.9}$$

T_AC = Titrable Alkalinity Concentration

(v) **Total Iron (Fe):** To 50ml of the sample will be added 1ml of hydroxylamine and 20ml of concentrated HCl. The mixture will be digested by evaporating it to about half the original volume. The process of digestion will remove all unwanted materials (organic) and will leave only iron to be determined.

The digested mixture will be poured into 50ml standard flask and made up to the 50ml mark with distilled water. The result will be compared with standard preparation using the colorimetric method.

(vi) **Total Hardness:** This is the sum of alkaline earth (Calcium and Magnesium) ions bond as carbonates, sulphates, chlorides and phosphorus expressed in mg/ℓ.

Reagents: 10% NH_3 solution (Ammonium chloride)

N.A.N.A. Indicator (Hydroxy-1-(2 hydroxy)-4-sulp-1-naphthlazo)-3 naphthoic acid

Black Eriochrome T

Ethylene Diomine tetracetic acid (EDTA)

Procedure: 100ml of effluent sample will be pipetted into a conical flask. 5ml of NH_3 buffer solution will then be added followed by the addition of a very little quantity of black Eriochrome T and the mixture warmed to 50°C. Titration with 0.01M EDTA will be carried out until colour turns from red to blue.

$$\text{Total hardness} = \frac{V_A \times 100}{V_S} \text{ (mg/ℓ)} \quad \text{---------- 3.10}$$

where: V_A = Volume of 0.01M EDTA used

V_S = Volume of sample used

(vii) **Chlorides (Cl^-):** To determine the chloride ion concentration, the sample of liquid waste (effluent) will be titrated with 0.01M $AgNO_3$ (silver trioxonitrate (V)).

Reagents/Chemicals: 0.01M $AgNO_3$ solution

0.1M HNO_3

10% Potassium chromate or phenolphthalein

Procedure: 100ml of effluent sample (filtrate) will be pipetted into a 250ml conical flask and 1-2 drops of phenolphthalein added. A red colour will be produced. 0.1M HNO_3 will be added until the solution becomes colourless. 2-3 drops of potassium chromate (K_2CrO_4) will then be added and the resulting yellow solution will be titrated with 0.01M $AgNO_3$ solution until the colour changes from yellow to reddish brown.

$$\text{Concentration of } Cl^- \text{ (mg/ℓ)} = \frac{(V_1 - V_2) \times 100}{V_S} \quad \text{---------- 3.11}$$

Where: V_1 = Volume of $AgNO_3$

V_2 = blank

V_S = Volume of sample

(viii) **Nitrite and Nitrate:** Nitrate in effluent will be determined by measuring 20ml of effluent sample into a 50ml volumetric flask and titrated with sulphanide acid.

(ix) **Chemical Oxygen Demand (COD):** The test for Oxygen consumed from potassium dichromate in acid solution is COD. It is a measure of the amount of carbon in many types of organic matter. It is of considerable value as an estimate of the strength of those sewages and industrial wastewaters for which biochemical oxygen demand (BOD) cannot be determined because they are toxic to the organisms activating the BOD test.

Reagents: 0.01M oxalic acid ($C_2H_2O_4$)

0.1M $KMnO_4$

8% NaOH (8g dissolved in 100ml distilled water)

Procedure: 10ml of the effluent sample will be transferred into a conical flask and diluted to 100ml with pure water. 2ml of 8% NaOH solution will be added and the mixture heated to boil. 10ml of $KMnO_4$ will then be added and boiling continued for about 15 minutes. Finally, add 10ml oxalic acid and back titrate the solution (hot).

$$COD = \frac{\text{ml of 0.1M } KMnO_4 \text{ x 0.08 NaOH x 1000}}{\text{ml of sample}} \quad \text{---------- 3.12}$$

(x) **Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD):**

The BOD test evaluates the loss of DO that accompanies the decomposition induced and maintained by micro-organisms in the wastewaters. Therefore, the BOD is an indirect measure of the amount of decomposable matter present and a direct measure of the respiratory oxygen requirements of the living organisms that are responsible for the decomposition.

The Dissolved Oxygen will be determined on days 1 and 5 (i.e. DO_1 and DO_5). After 15 minutes preparation, the DO for the diluted sample will be measured (blank with water only). The dilution of 850ml of clean tap water and 50ml of filtered sample will be fed into an incubator bottle. 2ml of concentrated H_2SO_4 will be added and shaken until the precipitate dissolved. 100ml of the resulting solution will be transferred into a conical flask and allowed to filter with an oil dilution of sodium thiosulphate ($Na_2S_2O_3$). Few drops of starch solution will be added as an indicator until the mixture becomes blue colour. The

quantity of $Na_2S_2O_3$ which will turn the sample colour to colourless (neutralization point) will be recorded as the DO in the sample. The determination of BOD_5^{20} will be done using the following equation:

$$BOD_5^{20} = \frac{DO_1 - DO_5}{D_1} \quad \text{..... 3.13}$$

Where DO_1 = Dissolved Oxygen of diluted sample 15 minutes after preparation

DO_5 = Dissolved Oxygen of diluted sample after 5 days incubation

D_1 = Decimal fraction of dilution water used

(xi) **Copper:**

Reagents/chemicals: Ashed sample

6M HNO_3

6M H_2SO_4

6M NH_3 solution

3M H_2SO_4

Phosphoric acid

Potassium iodide

0.01M $Na_2S_2O_3$

1% Starch

Procedure: 10ml of 6M HNO_3 will be added to 10g of the ash and heated. This dissolves the ash and will be allowed to cool. 10ml of 6M H_2SO_4 will next be added and the resulting solution heated to white fumes and then cooled. 20ml of water will then be added and the solution heated for 2 minutes. Cooled 6M

NH_3 solution will be added until there is a blue colour and 3M H_2SO_4 will be added to discharge the colour.

The solution will be transferred into a 200ml volumetric flask and made up to the mark with distilled water. 50ml of this solution will be pipetted into a 250ml volumetric flask to which 2ml of phosphoric acid will be added followed by the addition of 2g potassium iodide dissolved in 10ml of water. The resulting yellow solution will be titrated with 0.01M $Na_2S_2O_3$ with 2ml of 1% starch as the indicator. The titre value will be recorded and used to calculate the actual concentration of copper in the solution. Actual concentration of copper in the solution =

$$\frac{\text{titre value x molarity of } Na_2S_2O_3 \text{ x molar mass of Cu}}{\text{volume of sample}} \quad \text{---------- 3.14}$$

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Results

4.1.1 Experimental Result For Solid Waste

Experimental analysis was carried out on the solid waste sample from Nasco foods Nigeria Limited (Y). The samples were analysed. The percentages of each parameter were obtained as shown in table 4.1.

Table 4.1: Results for Solid Waste Analysis

	PARAMETERS	Y
1.	MOISTURE CONTENT (MC)	14.00
2.	DRY MATTER CONTENT (DM)	50.00
3.	LIPID CONTENT (LC)	1.69
4.	CRUDE PROTEIN (CP)	26.00
5.	CARBOHYDRATE (CHO)	24.00
6.	ASH CONTENT (AC)	2.80
7.	CRUDE FIBRE (CF)	2.50

4.1.2 Experimental Results for Liquid Waste

Experimental analysis was carried out on the liquid waste sample from Nasco foods Nigeria Limited (X). The result for each parameter were obtained as shown in tables (4.2, 4.3 and 4.4). The parameters are grouped into physical parameters, chemical parameter and organic parameter.

Table 4.2: Physical Parameters of Liquid Waste

	PARAMETERS	X	FEPA
1.	TEMPERATURE (^{O}C)	29.00	40
2.	PH	60.	6-9
3.	TURBIDITY (NTU)	13.20	NS
4.	CONDUCTIVITY (MS/CM)	0.20	NS
5.	TOTAL DISSOLVED SOLIDS (Mg/l)	210.00	2000
6.	OIL IN WATER (PPM)	5.60	10

Table 4.3: Chemical Parameters of Liquid Waste

	PARAMETERS	X	FEPA
1.	SULPHATE (SO_4^{2-}) mg/l	12.00	500
2.	REACTIVE PHOSPHATE (PO_4^{3-}) mg/l	0.12	5
3.	SULPHIDE (S^{2-}) mg/l	0.0021	0.20
4.	CHROMIUM (Cr^{6+}) mg/l	0.020	<0.1
5.	CHLORIDE (Cl^{-}) mg/l	29.80	600
6.	TOTAL IRON (Fe) mg/l	0.15	20
7.	NITRATE (NO^{-}_3) mg/l	0.80	10
8.	NITRITE (NO^{-}_2) mg/l	0.30	NS
9.	ALKALINITY mg/l	ND	ND
10.	CHLORINE (Cl_2) mg/l	0.0020	1.20
11.	COPPER (Cu) mg/l	0.13	1.50

N.B NS – NOT SPECIFIED

ND – NOT DETERMINED

Table 4.4: The Organic Parameter of Liquid Waste

	PARAMETER	X	FEPA
1.	CHEMICAL OXYGEN DEMAND (COD) Mg/l	200.00	80
2.	BIOCHEMICAL OXYGEN DEMAND (BOD) Mg/l	150.00	40
3.	DISSOLVED OXYGEN (DO) Mg/l	3.50	Ns

4.1.3 Quantity of Solid and Liquid Wastes Generated

The average production working days in a years for the Food Processing Company considered is 200 days out of 260 working days in a year. The difference of 60 days was as a result of public holidays, non-production days, faults and turn-around maintenance (TAM).

The average working hours per day is 5 hours. Using this time schedules, it was possible to quantify both solid and liquid waste of Nasco Food Nigeria Limited.

The results for the solid and liquid waste generated are in the table 4.5 and 4.6. respectively.

Table 4.5: Quantity of Solid Wastes Generated

LOCATION	AVERAGE DISCHARGE (Kg/s)	AVERAGE DISCHARGE (Kg/hr)	TOTAL DISCHARGE (TONNES/YEAR)
Nasco Foods	1.03	3.60	3600

Table 4.6: Quantity of Liquid Wastes Generated

LOCATION	AVERAGE DISCHARGE (HECTOLITRES/SEC.)	AVERAGE DISCHARGE (HECTOLITRES/HR)	TOTAL DISCHARGE (HECTOLITRE/YEAR)
Nasco Foods	1.03	3.60	3600

4.1.4 Analysis for Solid Wastes (Y)

$$\text{Arithmetic mean } \bar{Y} = \frac{\Sigma(Y)}{n}$$

$$= \frac{100.99}{7} = 14.4$$

Table 4.7 Standard Deviation for solid wastes

Y	$(Y-\bar{Y})$	$(Y-\bar{Y})^2$
14.0	-0.4	0.16
30.0	15.6	243.4
26.0	11.6	134.6
24.0	9.6	92.2
2.8	-11.6	134.6
1.69	-12.7	161.5
2.5	-11.9	141.6

$$\Sigma(Y-\bar{Y})^2 = 908.1$$

$$\text{Standard deviation } S.D_Y = \sqrt{\frac{\Sigma(Y-Y)^2}{n-1}}$$

$$= \sqrt{\frac{908.1}{7-1}}$$

$$= 12.3$$

4.1.5 Analysis for Chemical Constituents of the Effluents (Xc)

Arithmetic mean $(\bar{X}_C) = \frac{\Sigma (X_c)}{n}$

$= \frac{43.32}{11} = 3.9$

Table 4.8:Standard Deviation for Chemical Constituents for the Effluents

X_c	$(X_c - \bar{X}_c)$	$(X_c - \bar{X}_c)^2$
12.0	8.1	65.6
0.12	-3.8	14.3
0021	-3.9	15.2
0.020	3.9	15.1
29.8	25.9	670.8
0.15	-3.8	14.1
0.8	3.1	9.6
0.3	3.6	13.0
0.002	3.9	15.2
0.13	3.8	14.2

$\Sigma (X_c - \bar{X}_c)^2 = 847.1$

Standard deviation $S.D_c = \sqrt{\frac{\Sigma (X_c - X_c)^2}{n-1}}$

$= \sqrt{\frac{847.1}{10}}$

$= 9.2$

4.1.6 Analysis for Organic Constituents of the Effluents (X_o)

Arithmetic mean $\bar{X}_0 = \frac{\Sigma(X_0)}{n} = \frac{353.5}{3}$

$= 117.8$

Standard deviation $S.D_O = \sqrt{\frac{\Sigma(X_O-\bar{X}_O)}{n-1}}$

Table4.9: Standard Deviation for the Organic Constituents of theEffluents

X_O	$(X_O-\bar{X}_O)$	$(X_O-\bar{X}_0)^2$
200.0	82.2	6756.8
150.0	32.2	0136.8
3.5	-114.3	13064.5
	$\Sigma(X_O-\bar{X}_O)^2$	=20858.1

$= S.D_o = \sqrt{\frac{20858.1}{3-1}}$

$= \sqrt{10429.1}$

$= 102.1$

4.1.7 Analysis of Physical Parameters of the Effluent (Xp)

Arithmetic mean $\bar{X}_p = \frac{\Sigma(x_p)}{n} = \frac{264}{6} = 44$

Standard deviation $S.D_p = \sqrt{\frac{\Sigma(X_p-\bar{X}_p)^2}{n-1}}$

Table 4.10: Standard Deviation for Physical parameters of the Effluents

X_p	$(X_p-\bar{X}_p)$	$(X_p-\bar{X}_p)^2$
29.0	-15	225
6.0	138	1444
13.2	130.8	948.6
0.2	143.8	1918.4
210	166	27556
5.6	138.4	1474.6
	$\Sigma(X_p-\bar{X}_p)^2$	=33566.6
	$S.D_p =$	$\sqrt{\frac{33566.6}{6-1}} = 183.2$

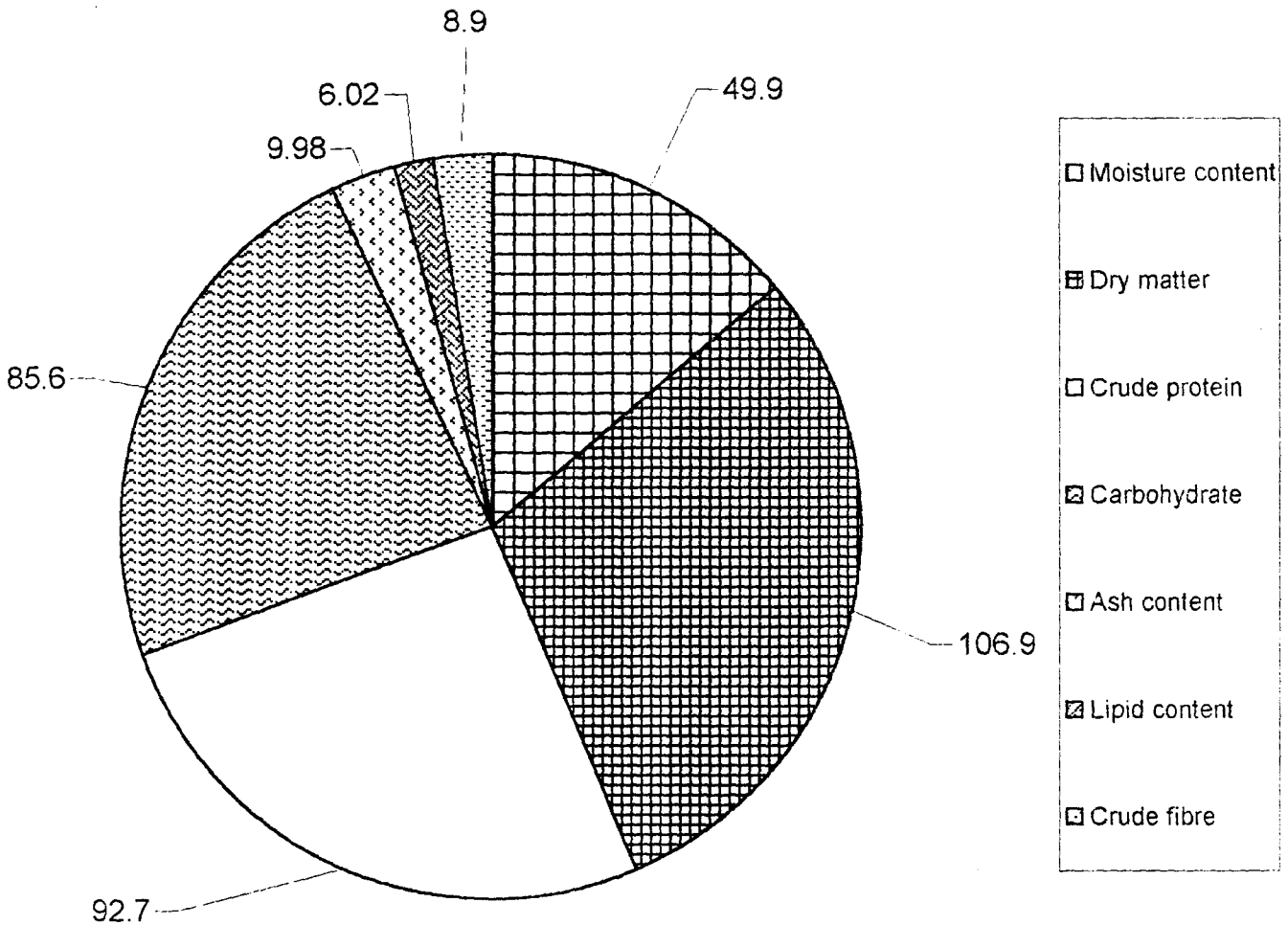

Figure 4.1: Constituents of the Solid waste from Nasco Foods Nigeria Limited.

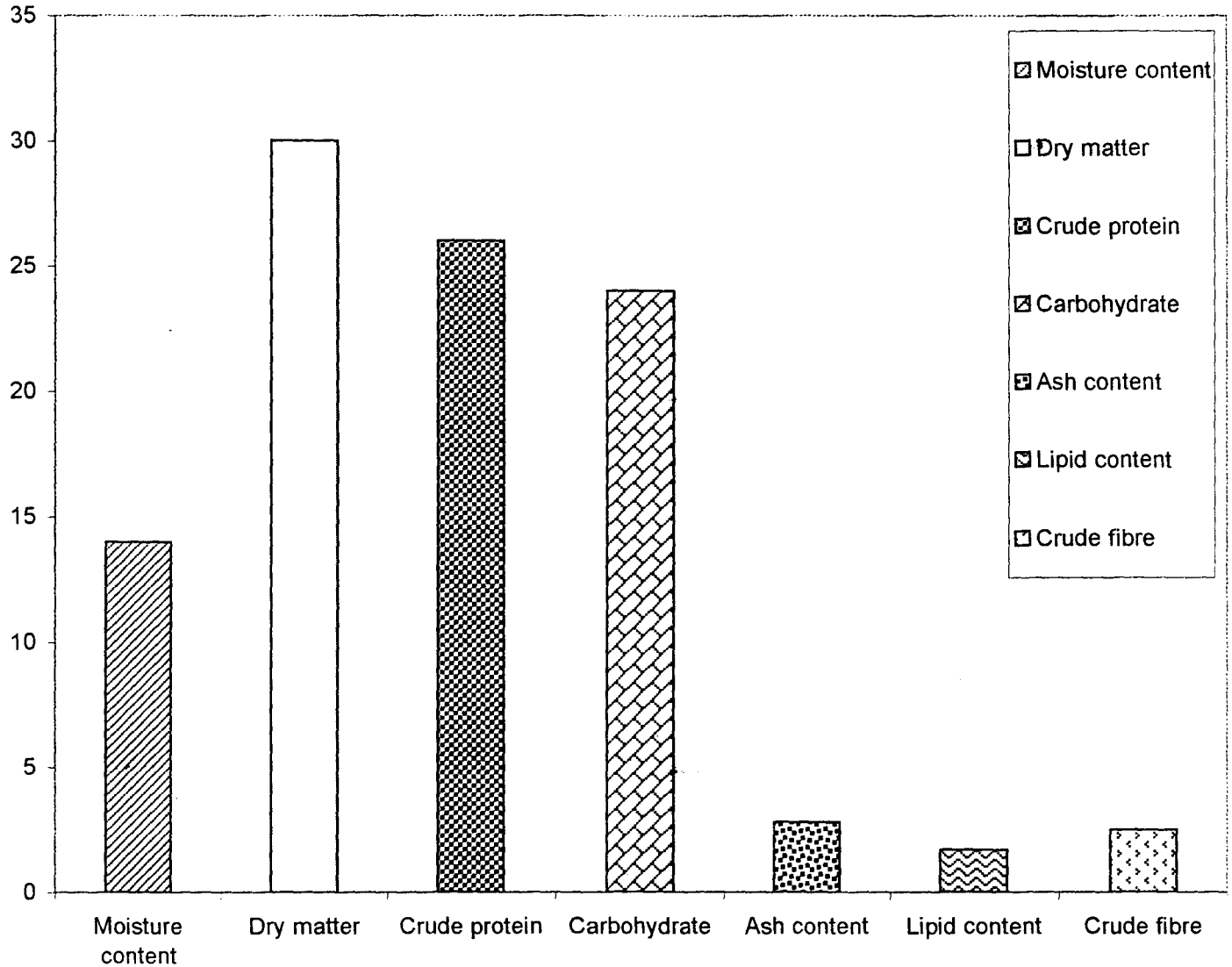

Figure 4.2: Constituents of the Solid Wastes from Nasco Foods Nigeria Limited.

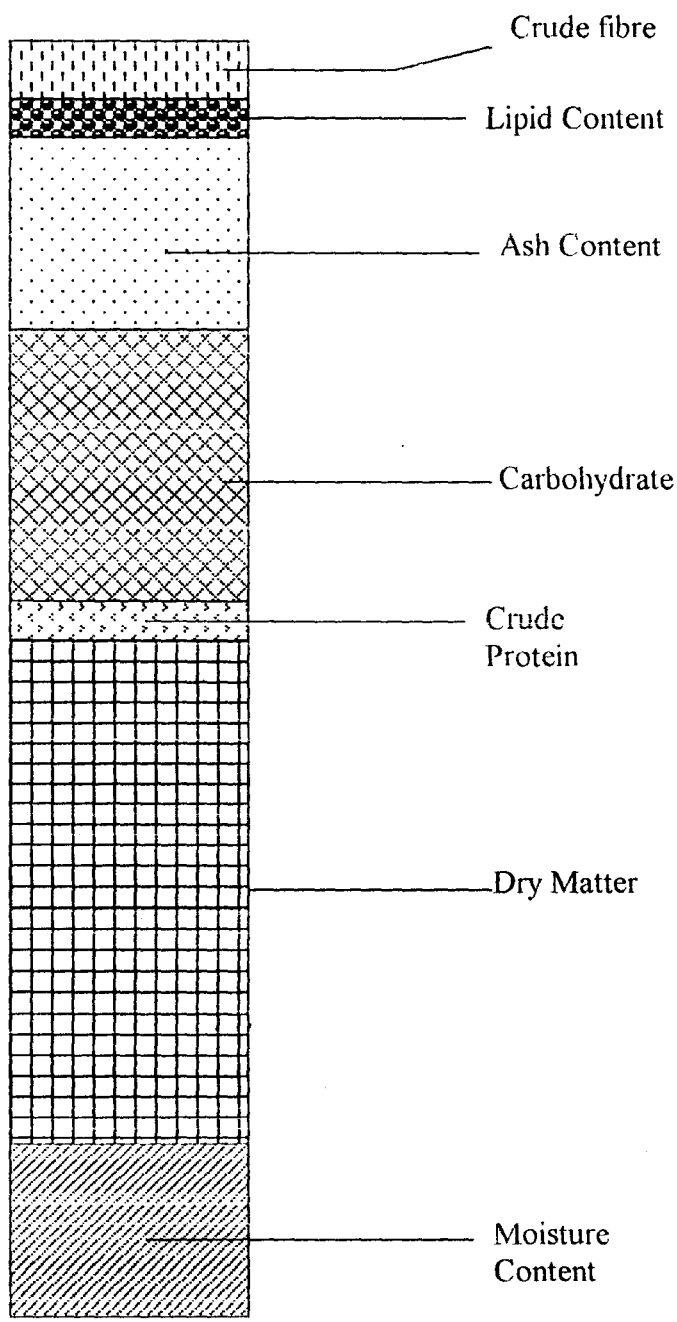

Figure 4.3: Component Bar chart for the Constituents of the Solid Waste from Nasco Foods Nigeria Limited

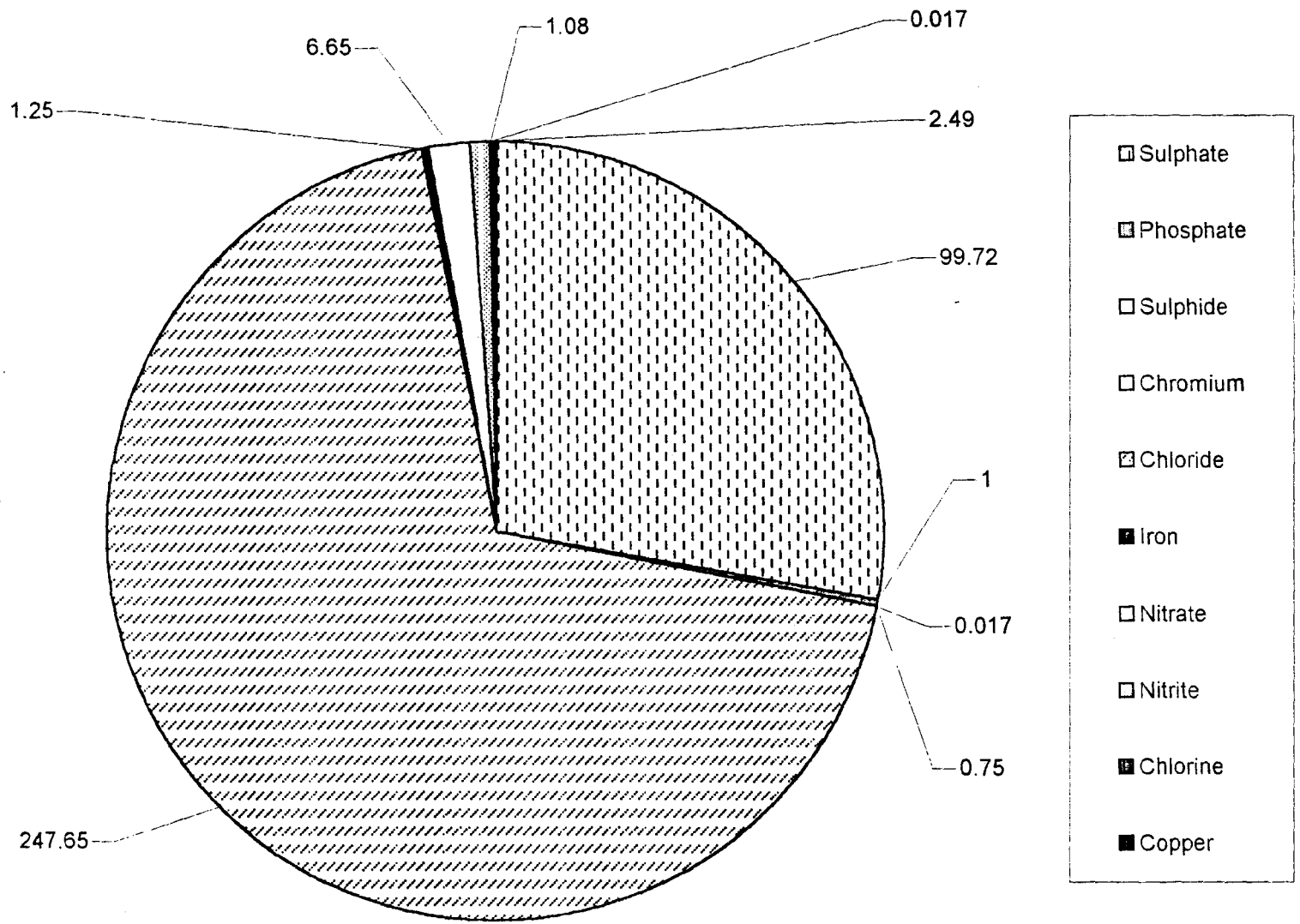

Figure 4.4: Chemical Characteristics of the Liquid Wastes from Nasco Foods Nigeria Limited

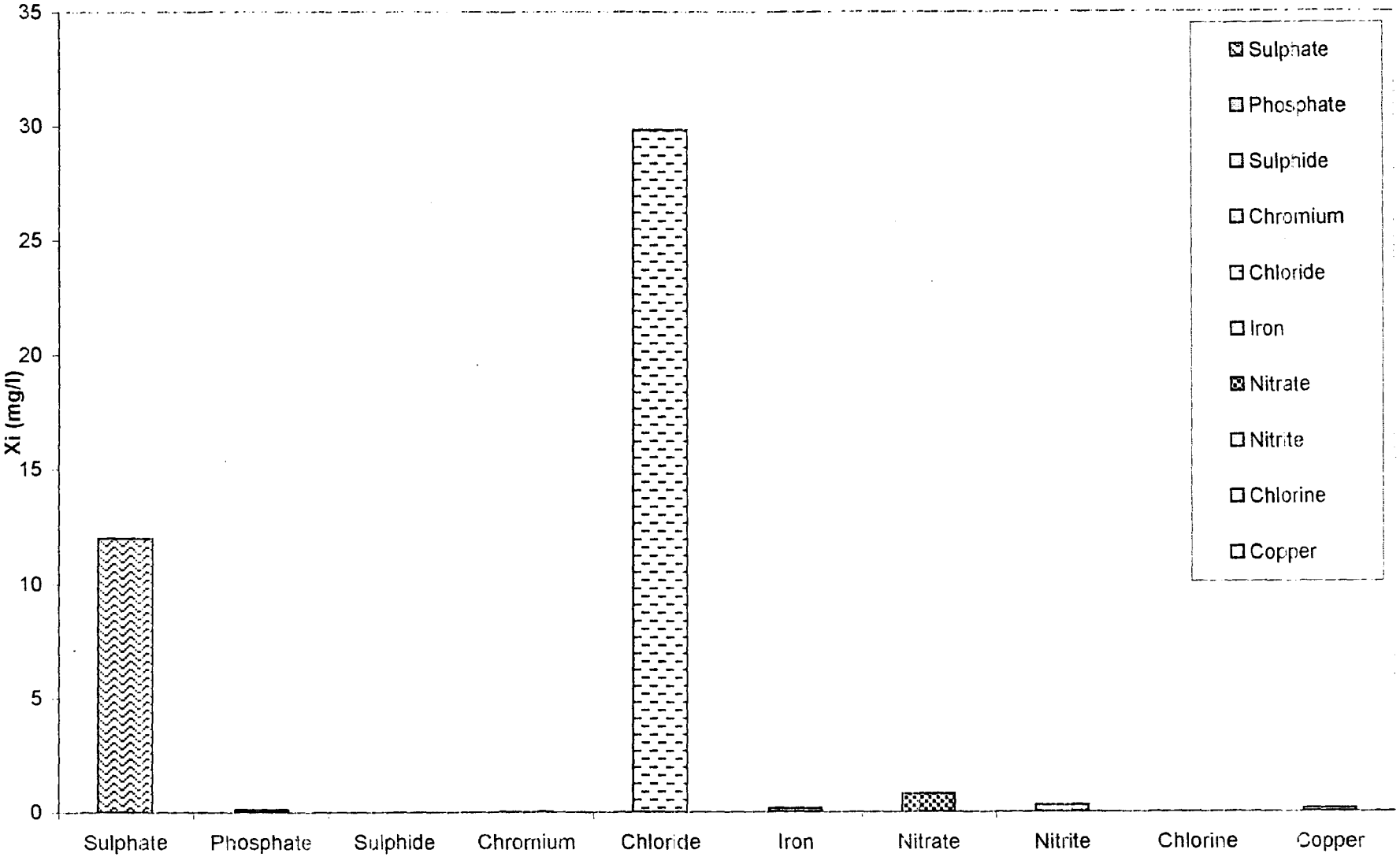

Figure 4.5; Chemical Characteristics of the Liquid Wastes from Nasco Foods Nigeria limited.

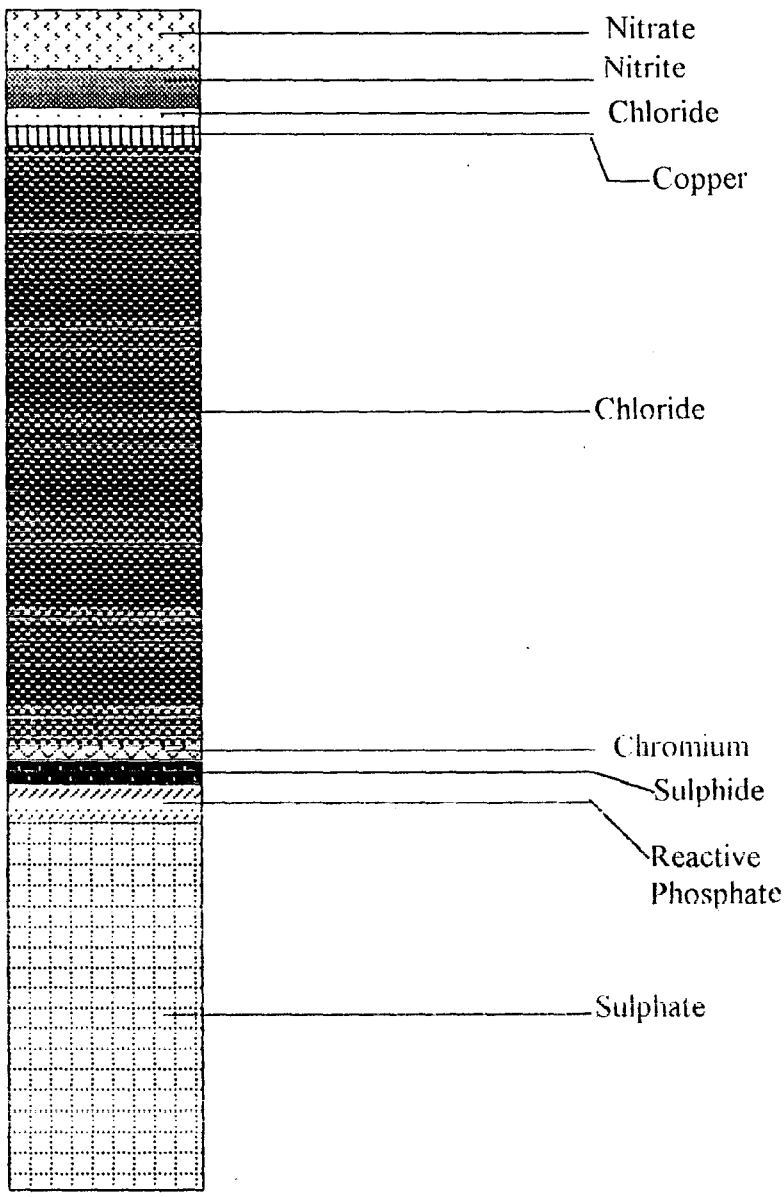

Figure 4.6: Component Bar chart for the Chemical Parameters of the Liquid Wastes from Nasco Foods Nigeria Limited

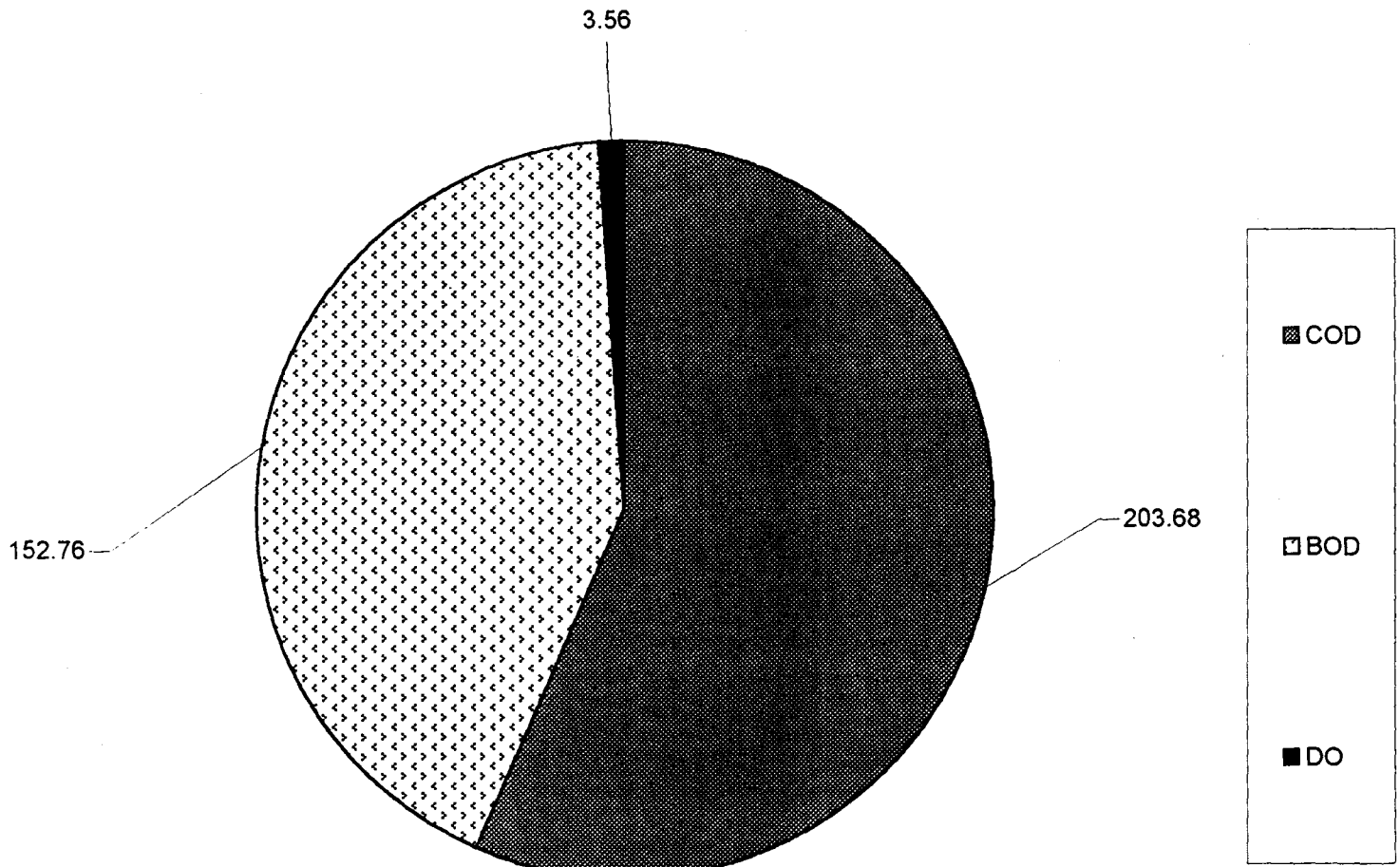

Figure 4.7: Organic Characteristics of the Liquid Wastes from Nasco Foods Nigeria Limited.

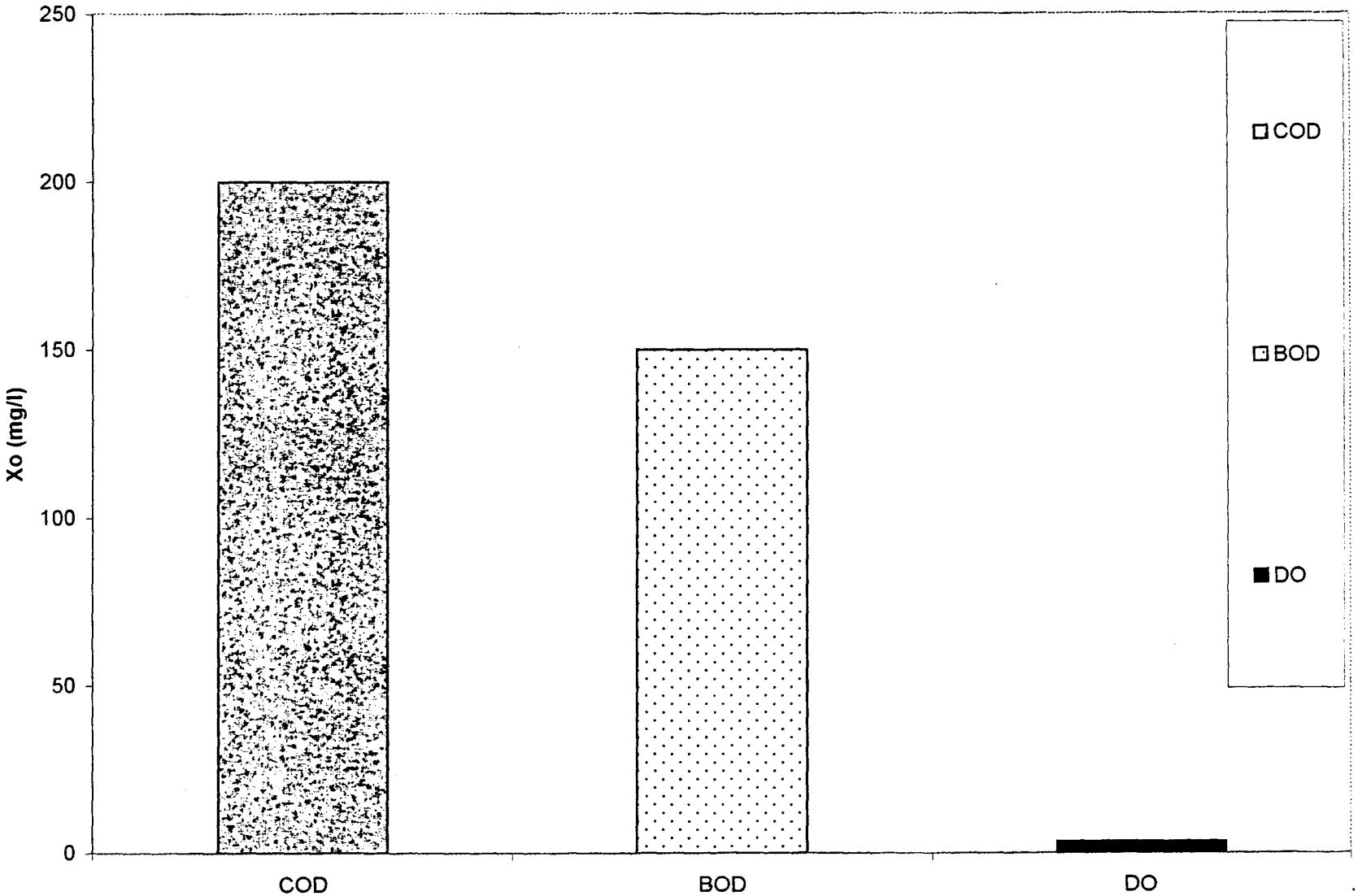

Figure 4.8: Organic Characteristics of the Liquid Wastes from Nasco foods Nigeria Limited.

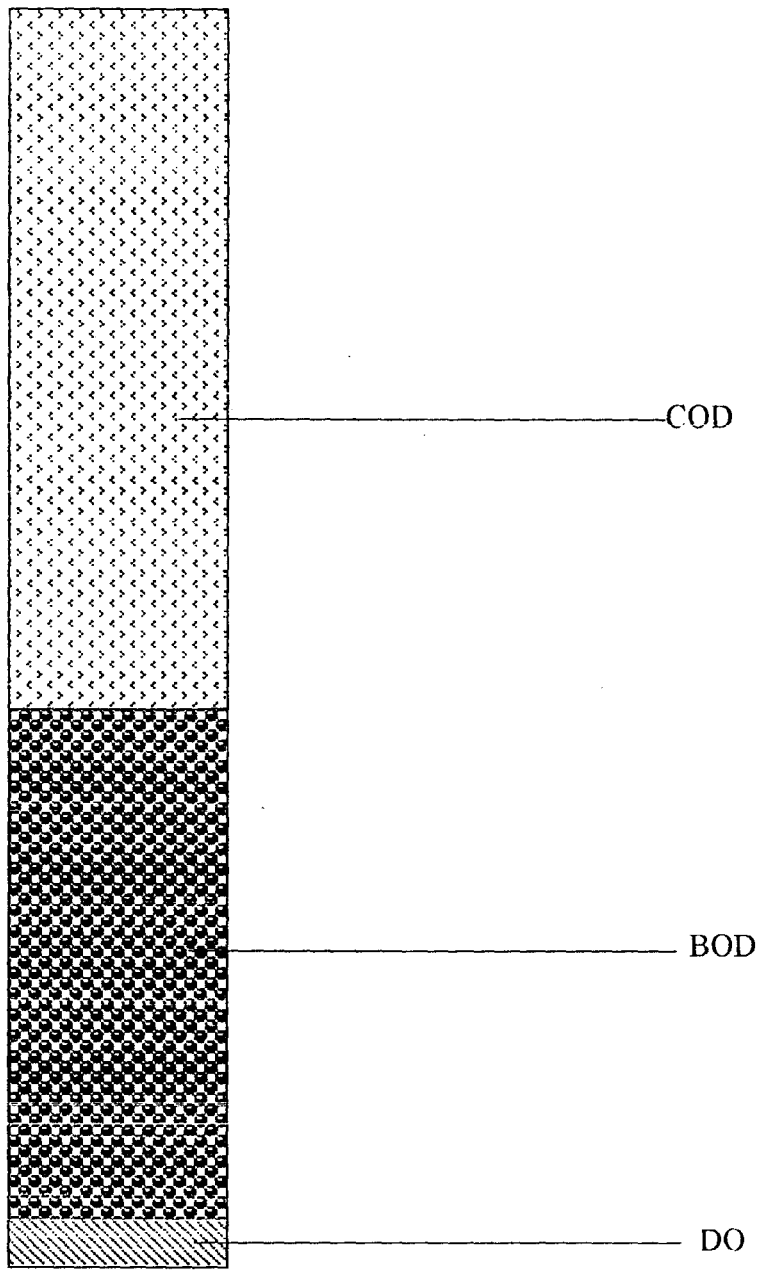

Figure 4.9: Component Bar chart for the Organic Constituents of Liquid Wastes from Nasco Foods Nigeria Limited

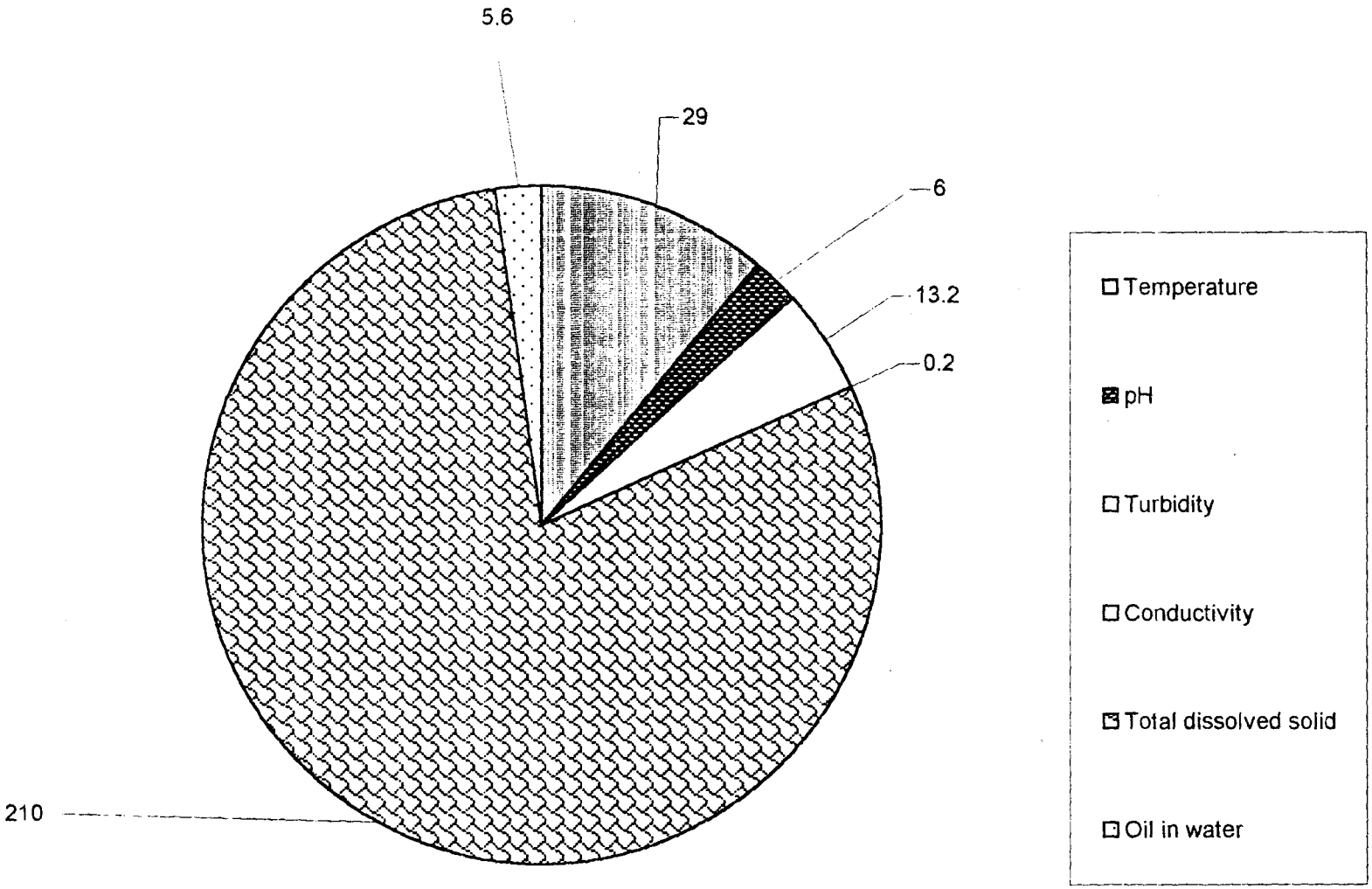

Figure 4.10Physical Characteristics of Liquid Wastes from Nasco Foods Nigeria limited.

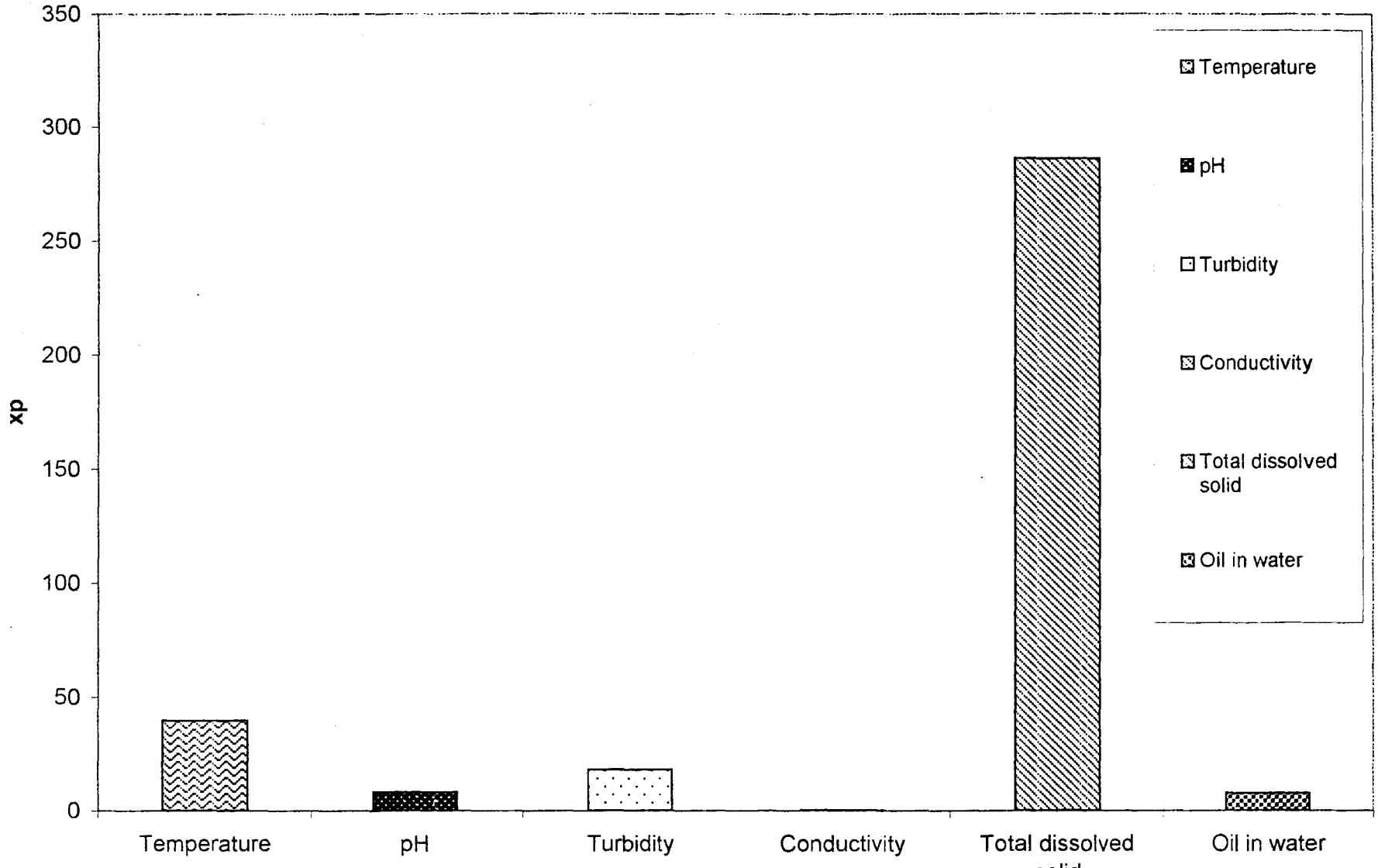

Figure 4.1: Physical Characteristics of Liquid Wastes from Nasco Foods Nigeria Limited.

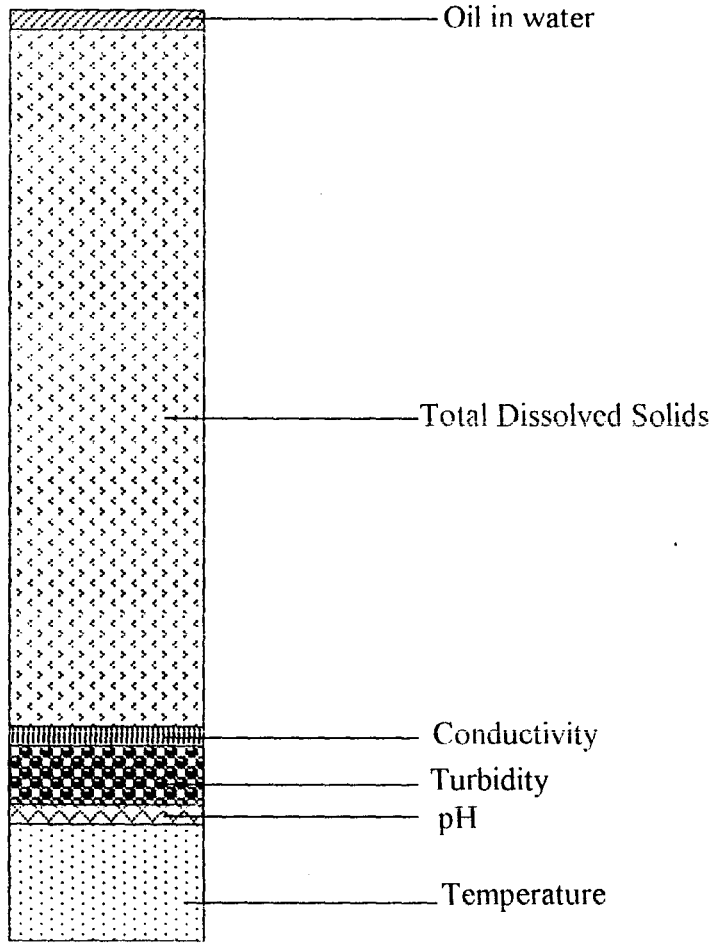

Figure 4.12 Component Bar chart of physical parameters from Nasco Foods Nigeria Limited.

4.2 Discussion of Results

4.2.1 Solid Waste

a) The result of the analysis of the solid waste indicates that MC value is 13.86% this shows that all samples collected are slightly wet. It makes it vulnerable to speedy biodegradation by micro-organisms couples with the fact that it is organic in nature. The presence of MC also makes immediate use possible for vital feeds.

The percentage of the dry matter content (DM) is 29.71%. It is the ratio of the dry weight to the solid waste expressed in percentages.

The lipid content (LC) is 1.67%. It is a measure of fat content of the feed and according to Eusebio (1984), pigs require high protein and or high fat content feed up to 3% because these nutrient are easily digestible.

Crude protein (CP) content is 25.75%, which is high enough for poultry feed. Poultry requires a feed with high protein level of (22%CP) and a high metabolizable energy source (2200Kcal/kg-3600Kcal/Kg ME). This can only be obtained for the crude protect and carbohydrate sources of their diet.

The carbohydrate (CHO) level in the analyzed sample is 23.76%, which indicates that the food waste is a good source of energy for the livestock feed.

The Ash content (AC) value 2.77%. The crude fibre of a feed is an important fact of a diet, it is 2.48% and according to Pfizer (1985) the crude fibre should be 3.16% for livestock feed.

b) From the bar graph, it shows that dry matter has the highest level with 29.71% and lipid content to be 1.67% as the least.

The pie chart shows the segment in percentages occupied by the parameters.

4.2.2 Liquid Waste

4.2.2.1 Physical Parameters of Liquid Waste

a) The results of the liquid waste analysis indicate that the temperature is 29^0C, which is within the recommended limit by FAO (1992) of 25 to 30^0C. This also conforms to FEPA limit for effluent disposal, which must be less than 40^0C. A high temperature exceeding the limit can lead to thermal pollution of the environment, which is inimical to the existence of aquatic organisms.

The pH value is 6.00, which is within the recommended FAO limit and also conforms to FEPA standards (1990) of 6.0-9.0.

Turbidity is the estimate of suspended matter and the value is 13.2NTU. The FEPA, 1991 recommended standard is a value less than 10 (<10NTU). This shows that the effluents from Nasco foods is above the FEPA recommended

limit, this must have been as a result of the inefficiency of the stabilization pond to process the sediment particles of the cereal component and other suspended particles.. High turbidity above limits (10NTU) regulations can be responsible for a high deposition of suspended matter down stream, filling of natural aquifer (which alls for intermittent dredging) and filling of passage drains.

The conductivity is 0.20 Ms/cm which conforms with the FAO, 1992 recommended standard of 0.3Ms/cm for irrigation water use.. This indicates that the effluent is not expected to have any salinity related problems as the electrical conductivity gives a good estimation of the dissolved salts.

Total Dissolve Solid (TDS) is 210.0mg/c, this is far below the recommended value of 2000 by FEPA and FAO and since TDS is a general indicator of expected level of water pollution.

Oil in water has a value of 5.60ppm, which is less than the FEPA recommended value of 10ppm. A high level of oil in water surrounding bodies of water can lead to physical damage of the respiratory organ and suffocation of aquatic organism during the struggle to get oxygen for respiration.

4.2.2.2 Chemical Parameters of Liquid Waste:

The sulphate (SO^{2-}_4) value is 12.00mg/c, which is within the recommend value of 100mg/c. FAO (1992) limit, and 500mg/l FEPA (1990) limit. The result satisfies the criterion for use of the effluent as irrigation water.

Furthermore, sulphur is quite important to plants, it helps in the formation of certain protein and it is always found in the sulphates.

Reactive phosphate has a value of 0.12mg/l, which is less than the FEPA limit of 5mg/l. Phosphate helps in formation of nucleic proteins and co-enzymes. It also aids nuclear division in plant cells. It will be advantageous if the effluent is used as a source of irrigation water since it will compensate for phosphate deficiency in the soil.

Sulphide has a value of 0.02mg/l, which is less than the FEPA standard of 02.mg/l and FAO standard of 0.1mg/l.

Chromium content of the effluent is 0.02mg/l, which falls within FAO 0.05mg/l and FEPA 0.1mg/l. Chromium can be absorbed and accumulated by plant tissue, which may later be injurious to the consumer, chemical contamination or toxicity can result, if such an effluent is consumed in nearby bodies of water, plant survival is also threatened if the effluent is used for irrigation purpose without treatment. This is because the plant tissue absorbs the chromium which their body systems cannot breakdown, it thus intoxicate the cell systems until it collapse.

Chloride has a value of 29.80mg/l which is within FAO, 1992 (300mg/l), FEPA, 1990 (600mg/l) and WHO (250mg/l) recommended values. The use of this effluent will be devoid of chloride related problems. Chloride ions are

absorbed by plant tissue and accumulate in the leaves resulting in leaf burns when present in excess amount.

Total iron from the effluent sampled has a value of 0.15mg/l, which is still within the acceptable FAO 5.0mg/l, FEPA 20mg/l and WHO recommended limit of o.3mg/l. Presence of iron can cause turbidity and iron bacteria. It can be removed from water by conventional water treatment or iron exchange.

Copper is part of the heavy metals that can cause contamination in water quality when the concentration exceeds the limit. The experimental analysis gives a result of 0.13mg/l, which is within FEPA (1990) limit of 1.5mg/l, EPA 1.3mg/l and WHO 1.0mg/l. However, it does not conform to FAO limit of 0.1mg/l. Copper in excess can give a bitter metallic taste to water, it is toxic to fish, it causes corrosion of galvanized iron and steel fillings. It is essential for life. Daily adult requirement is 2.0mg coming mostly from food. Copper can be removed by iron exchange, conventional coagulation, sedimentation and filtration.

Nitrate has a value of 6.80mg/l, which is less than FAO (30mg/l) and FEPA10mg/l. The Nitrate level indicates the ammonium level since they are both salts of nitrogen. Excessive content of nitrogen (iv) oxide can make available excess nutrients, which when in high concentration can lead to significant loss of yield, through lodging,, failure to ripe, increased susceptibility to pests and diseases as a result of over luxurious vegetative growth (mathaeomglobineamia) when the effluent is used for irrigation purposes. Nitrogen II oxide (Nitrite) is an

indication of pollution when present in wastewater and the value from experiment shows 0.30mg/l, which is a non specified value by FEPA.

Alkalinity indicates the presence of bicarbonate and carbonates in water. High carbonate level leads to encrusation in plants if the effluent is used for agricultural purposes like irrigation. Excess alkalinity in water can cause eye irritation if such water is used for bathing. Since experimental result does not detect alkalinity, there must have been carbonate fixation.

Chlorine has a value of 0.0020mg/l, which is within FAO (1.1mg/l) and FEPA (1.2mg/l) limits. Excessive chlorine can lead to bleaching potentials if the water is used for laundry at the down stream.

4.2.2.3 Organic Parameters of Liquid Waste

Chemical Oxygen Demand (COD) has a value of 200mg/l. It does not fall within the limit of FEPA 80mg/l. High level of COD indicates organic matter susceptibility to oxidation by a strong chemical oxidant. That is, the effluent will have adverse effects on soil nutrient and even plant and water treatment cost.

Biochemical Oxygen Demand (BOD) has a value of 150mg/l, which is above the FEPA limit of 4mg/l, and the FAO, 1992 specification of 20mg/l. BOD is a measure of the extent of biodegradable organic matter. This shows that the effluent from Nasco foods are dangerous to aquatic organisms survival since the

available oxygen for respiration is drastically reduced as a result of the biodegradation process.

Dissolved Oxygen (DO) has a value of 3.50mg/l. This parameter was not specified by FEPA. Game fish requires at least 4 to 5mg/l of DO. Absence of DO leads to anaerobic conditions, putrefaction or foul odour. Cold water holds more oxygen is solution than warm water. Thus, since the effluent is always warm at the point of discharge, the DO is low, a situation that could lead to depletion of life organism in the effluent sink.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In this study, the solid waste analysis shows that Nasco foods is at an average M.C of 13.86 % which makes the waste vulnerable to microbial attack especially at a discharge temperature of 29.40C. The other parameters indicated that the waste is nutritious and can be supplemented with other materials to make a balanced livestock feed. Furthermore, the waste can serve for organic manure production and recycled for feeds.

The result also shows that out of the 20 parameters examined for the wastewater: Dissolved solid, Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) are significantly different in terms of their concentration, that is their presence is more registered than any other parameters. The COD and BOD exceed the FAO, (1990) and FEPA, (1992) limits. Thus, these two parameters are potential sources of environmental degradation and pollution of receiving streams.

The study has been able to accomplish the desired goals and objectives for the research, even though works still needs to be done on the quality and quantity of the gaseous wastes.

5.2 Recommendation

The management observed that the cost involved as in compliance with this environment pollution control is high, but is not all unreasonable in view of the inherent changes of taking these problems lightly. Hence, Nasco Foods, monitor their effluent so as to reduce the negative impact of their operations on the environment.

In addition to the treatment of the liquid waste, advance treatment of the effluent using ultraviolet radiation methods should be introduced to the system in order to improve the quality of the effluent that is been discharged into the flowing stream.

The industry must conform to FEPA limit.

REFERENCES

Adegoke, A.O. (1992). Heavy metal contents of some solid wastes in Ibadan, Nigeria. Journal of Water, Air and Soil Pollution, No. 29 pp 57-59.

Ajisegiri, E.A.S, Chukwu, O., Odigure, O., Jimoh, O.D., Adeyi, O.D. and R.O Olagunju (2002). Environmental Impacts from industrial operation: Case study of food processing industries in Nigeria. A seminar paper delivered at Federal University of Technology, Minna, Niger State.

Burgess, J.V. (1973). Incineration of Industrial Solids and Liquids. Industrial pollution control. 1st Edition. Business Books Limited. Pp. 20-216.

Champ, M. and Park, P.K. (1981). Ocean dumping of sewage. A global review. SEA Tech. Vol. 22, No. 2, pp 18-22.

Chukwu, O. (1994). Technical Evaluation of Rice Threshers in use in Niger State, Nigeria. Unpublished M.Eng. Project, Department of Agric. Engineering, U.N.N., Enugu State, Nigeria.

Chukwu, O. (2003). Department of Agric. Engineering, Federal University of Technology, Minna. Personal Communication.

Coker, A.O., Akanmu, A.M., Sridhar, M.K.C. and I.O. Aladenola (2002). Management of pollution from an incinerator in Ibadan, Nigeria, Pp 253-260.

Eckenfelder, Jr. (1989). Industrial water pollution control. Mc-Graw Hill Books, 3rd Edition, pp. 12-32.

Eusebio, J.A. (1984). Pig production in the Tropic. Science Books 2nd Edition, Pp 20-50.

FEPA (1990). Environmental Sanitation Engineering. Mc-GrawHill, 4th Edition, Pp 2051 – 2889.

FEPA (1989). The environment in Nigeria and sustainable development in Nigeria. Proceedings of a workshop held at the Nicon Nigeria Hilton Hotel, Abuja, Feb. 25-26th April.

FEPA (1991). National Interim Guidelines and Standards for Industrial Effluent, Gaseous Emissions and hazards Wastes, Pp 33-63.

Food and Agriculture Organisation (FAO) (1952). FAO Trade Year Book 1952, Vol. 50.

Food and Agriculture Organisation (FAO) (1992). Environmental Sanitation Engineering. Mc-GrawHill, 4th Edition, Pp 2051 – 2889.

Harrison (1999) Waste Auditing and Minimization: Practical study and case studies, Pg. 41-45

Harrogate, S.H. (1960). Hazardous Wastes Management.

Kumapayi, O.K. (1994). Preliminary studies of some industrial effluents disposal methods from Ibadan Metropolis and their potential for irrigation.

Luo, A. and Siln, X. (1995). Effect of organic manure of the biological activities associated with insoluble phosphorus released in blue paddy soil. Communication in soil science and plant analysis. Vol. 25, No. 13 and 14, pp. 2513-2522.

Metalf and Eddy, I. (1979). Waste Water Engineering Treatment, Disposal, Re-use. Mc-Graw Hill, New York, 2nd Edition. Pp 105-108.

Ojo, O.O. (1997). Recycling of Brewer's waste: A case study of Nigerian Breweries Limited. A seminar paper delivered to the Department of Agricultural Engineering, Federal University of Technology, Minna.

Osuji G.C.E, A.Y Sangodoyin and L.A Ogungbe (1998). Studies of water use and re-use in the industries, Agricultural and domestic sectors (western

Nigeria): Implication for water resources planning proceedings C.I.G.R international sections symposium Ilorin, Nigeria 5-10 September 1996 PP. 355-360.

Pfizer (1985). Published in Dailies April 4th, 1986.

Salvato, A. (1992). Environmental Sanitation Engineering. Mc-Graw Hill, 4th Edition. Pp 2051-2889 (Source for FAO, WHO and FEPA effluent standards.

Standard Organization of Nigeria (SON) Illustrated Environmental studies, pg. 13-15.

Susu, A.A. (1995). Waste minimization option within a sustainable environment. Technical paper delivered at the National Environmental Science seminar week at Lagos.

Tokun (1979) Assessment of Solid Waste Management problems in Nigeria Pg. 19

Wallis (1989). Environmental Impact Assessment, McGraw Hill Books, Vol. 2, Pg. 14-25.

Williams P.T. (1988) Waste Treatment and Disposal. John Wiley and Sons Ltd. London, Pg. 53-57

World Health Organization (WHO) Environmental Education in U.S.A Vol. xii, Pg. 5.

Woslten sholme, R. (1993). Applying sewage sludge to forest research. Oxford Press Focus 3rd Edition, No. 12, pp 3-4.

APPENDIX

DEPARTMENT OF AGRICULTURAL ENGINEERING
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

A study on the Quantitative and Qualitative analyses of wastes from Nasco Foods Nigeria Limited.

QUESTIONNAIRE:

Questionnaire Administrator: Mr. Bashir Taufeeq. A
Department of Agric. Engineering,
Federal University of Technology,
Minna.

Dear Respondent(s),

Feel free to answer the questions asked, for an objective assessment of your industry.

1. Name of Industry:

2. Year established in Nigeria:

3. Location (Head office):

4. Location (Branch office) (i) (ii) (iii)

5. Name of different departments/Sections:

   (i)
   (ii)
   (iii)

6. Number of Employees:

(i)	Permanent staff	(a)	(b)
(ii)	Temporary staff	(a)	(b)
(iii)	Casual workers	(a)	(b)

a = Expatriate b = Nigerians

7. Type of industry:

   (i) manufacturer
   (ii) importer
   (iii) exporter
   (iv) others (specify)

8. Type of activity (activities) of the industry:

   (i) whole manufacture
   (ii) part/component manufacture
   (iii) percent of component manufacture
   (iv) whole importer

9. State the products manufactured by the industry

   (a) (b) (c) (d) (e) (f) others

10. What is the estimated quantity of each product in

    (i) a day
    (ii) a week
    (iii) a month
    (iv) a year

11. What unit operations/processes are involved in the manufacture of each product? E.g. Raw material → washing → grinding → heating

12. What are the raw materials for your products?

13. What quantities of the raw materials do you procure?

14. What are the sources of the raw materials?
    (i) imported
    (ii) sourced locally in the market
    (iii) Industry's farm

15. How are the raw materials supplied/transported
    (i) by air
    (ii) by road
    (iii) by rail
    (iv) by sea

16. How do you procure your machines/machinery?
    (i) imported
    (ii) fabricated locally
    (iii) indigenous design

17. What waste(s) do you generate as a result of the industrial activities

    (i) solid
    (ii) liquid
    (iii) gaseous

18. How do you handle the waste(s)?
    (i) burn them
    (ii) bury them
    (iii) others, specify

19. Do you carry out waste treatment?

20. If yes to 19 above, specify

21. What effluent(s) do you generate during industrial activities?
    (i) liquid
    (ii) gaseous
    (iii) others, specify

22. How do you discharge your effl ient(s)?
    (i) into drains/gutters
    (ii) into running water
    (iii) exhaust gas(es) into the atmosphere

23. What is the level of toxic metals in your effluent?
    (i) high
    (ii) moderate
    (iii) low
    (iv) nil

24. Rank/Designation of officer(s)/interviewee/respondent

25. Department/section of interviewee/respondent

26. Age (years)

27. Educational Qualification (highest)

28. Date of first appointment/how long have you been with the Industry/company

29. Nature of appointment (i) permanent staff (ii) temporary staff (iii) casual worker

30. Marital status