

**COMPARATIVE ASSESSMENT OF EARTH  
BRICK OVEN AND ELECTRICALLY  
POWERED TYPE**

**BY**

**NNAMDI UDODI OHUCHE  
MATRIC NO. 03/14839EA**

**BEING A FINAL YEAR PROJECT SUBMITTED IN PARTIAL  
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## DECLARATION

I hereby declare that this project is a record of research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any University or Institution. Information derived from personal communications, published and unpublished works of others were duly referenced in the text.

NNAMDI OHUCHE

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Name of Student

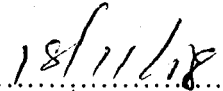
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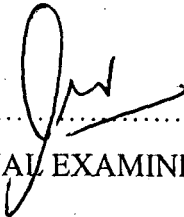
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ENGR. PETER IDAH  
Supervisor



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Date

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DR. MRS. Z. OSUNDE  
HEAD OF DEPARTMENT

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Date



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EXTERNAL EXAMINER



.....  
Date

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DR. MRS. Z. OSUNDE  
HEAD OF DEPARTMENT

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Date

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EXTERNAL EXAMINER

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## **DEDICATION**

I hereby dedicate this project to God Almighty, son and the Holy Spirit, the only wise God, and my only rescue at night.

## ACKNOWLEDGEMENTS

I am giving it all to my beloved and one and only parent, Chief and Mrs. Obediah Ohuche who have stood by me through the snares and made sure I was never perplexed. And also made sure I was not financially incapacitated, I remain ever grateful.

To my father, mentor, teacher, in person of Bishop David Oyedepo.

I am also giving it to my very humble supervisor whom through the hurdles of academic excellence has attained an un-depreciating height in person of Engr. Peter Idah and all the lecturer of the department of agricultural and bio-resources engineering (FUT Minna) for their love, during the course of this simplified research and to our mother Dr. Mrs Osunde.

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Finally I am giving it up to my dearest one Stepnie Ujunwa and also to the valours of my journey so far in persons of Mike Benjamin, Joshua Ochoge, Bro Danso Wilson. Emeka, Godwin, Ifeanyi Anyikamba Ibe, Fortune Madume, Zuikiflu El-rufai and Uncle Bode

## **ABSTRACT**

The present study shows the comparative assessment between the earth brick oven and the electrically powered type. The test was carried out for 6 days and the result shows that there was at least 5°C temperature reduction after first baking in brick oven and heat was steady in the electric oven and also compared to the brick oven the baking of the same dough size took lesser time in the electric oven than the brick oven, for the first baking with a time difference of 2 minutes, also colour changes of baked bread was noticed after first baking in brick oven while colour was even in electric oven. The storage test has it that bread from brick oven lasted for 6 days while that baked in the electric oven lasted for 5 days. From methods used in conducting this test it was concluded that electric oven is faster and efficient while brick oven was found to have more advantage than the electric oven based on baking result obtained.

## TABLE OF CONTENT

Title page	i
Declaration	ii
Certification	iii
Dedication	iv
Acknowledgement	v
Abstract	vi
Table of content	vii
List of Table	viii
List of figures	ix
List of plates	x
List of Appendices	xi
<b>CHAPTER ONE</b>	
1.0 Introduction	1
1.2 Problem Statement	2
1.3 Aims	2
1.4 Objective	3
1.5 Justification	3
1.6 Scope of Study	3
<b>CHAPTER TWO</b>	
2.0 Literature Review	4
2.1 Overview of Ovens	4
2.2 History of Ovens	5



2.3	Description of Brick Oven	8
2.4	Construction Process	10
2.5	Types of Back Oven	11
2.6	Mode of Usage of Brick Oven	12
2.7	Conventional Ovens	13
2.8	Types of Conventional Ovens	15
2.9	Advantages and Disadvantages of Each Oven	18
<b>CHAPTER THREE</b>		
3.0	Materials and Methodology	20
3.1	Materials	20
3.2	Preliminary Test on Samples	20
3.3	Method of Firing	21
3.4	Method of Comparism	21
3.5	Performance Evaluation	22
3.6	Comparism of Tests, Odour, Colour, Texture of baked product from each oven	22
<b>CHAPTER FOUR</b>		
4.0	Result and Discussion of Result	24
4.1	Result and Discussion	24
4.2	Taste	24
4.3	Odour	24
4.4	Colour	24
4.5	Storage	25
4.6	Rising Ability	25

4.7	Monitoring Time	25
4.8	Texture	26
4.9	Discussion of Result	26
<b>CHAPTER FIVE</b>		
5.0	Conclusion and Recommendation	28
5.1	Conclusion	28
5.2	Recommendation.	28
	Reference	35
	Appendix	36

## TABLE OF CONTENT

List of Table .....	25-27
List of Figures .....	30-32
List of Plate .....	33-34
List of Appendix .....	36-38

## CHAPTER ONE

### 1.0 INTRODUCTION

Ovens are enclosed compartment or receptacles for baking or drying food items. It is a compartment warmed by a heat source and used for baking regardless of the model or type. The model of an oven tells what it is made up of or characterized of, be it a brick oven or an Electric oven. The brick oven which is the local type or traditional oven is made of Brick which can be defined as a local building material, solid or hollow generally in the form of rectangular prism, formed from clay or shale and harden by burning. This oven type has been, described as a barrel vault; and also called a letter box oven (For no Bravo 1995). The foot print this oven is rectangular and the dome is a curved vault that looks much like a gothic cathedral. This traditional French and Scottish bread oven works well for large scale bread baking

Electrical oven on the other hand are ovens that generate their heat from heater elements for heating, baking or roasting purposes. This type of ovens are called modern ovens, because prior to the time of its invention ovens that existed were rather fueled by wood or coal (Local type), while this, type is fueled by electricity or gas. The use of an electric oven may depend on the purpose for the usage as we all know that electric ovens are of different sizes and types choice may depending on what the baker intends to achieve at the end of the baking process which will in turn save his cost of production.

Even with this development in ovens the basic function of the oven still remains the same as that of the early man but the variety of food items that use the oven increased rapidly and also the time factor improved considerably, there by making ovens in food processing industries of great significance in terms of advancing food productivity.

In Nigeria the use of oven for baking purpose is more of bread than other foods like pizzas or cakes this bread serves as a major food consumed daily in Nigeria and this makes its demand a continuous one all round the year. It is therefore necessary that the baking of this bread meet certain demands and standard at all times to maintain its quality and this may depend upon the kind of oven used in the baking process. Type or kind of oven needed in any bread production, depends on the scale of their production at a given time. This helps the baker in proper selection of ovens either in term of size, flexibility of use, ease of maintenance, cost ease of operation, cleanliness, operation time.

This project is in 5 chapters which is entirely the comparative assessment aimed at comparing the brick oven ( Local traditional oven) and the electrically powered type using burners and steamtubes and determining their efficiencies with respect to baking period on the product ( Bread).

## **1.2 PROBLEM STATEMENT**

In brick oven, temperature may be difficult to read because the it has no temperature control and this broadens the working in the collection of data. Unlike the electric oven which has a temperature control while baking. Seasonal changes may also affect the performance of brick oven in the sense that more heat is to be applied during the cold or rainy seasons and the baker burns more wood then.

## **1.3 AIMS**

The aim of this project is to carry out research/ test on performance of brick oven, and electric oven (with steamtubes) respectively and also comparing in details the advantage one has over the other when in use

#### 1.4 **OBJECTIVE**

The above aims will be pursued in line with the following objectives

1. To determine the baking performance of both ovens with respect to time used to bake the product ( Bread) when the same amount of heat is applied
2. To come out with the differences noticed in the product, and stating the advantage or disadvantage of one over the other.
3. To make possible recommendation based on the achieved result

#### 1.5 **JUSTIFICATION**

Ovens and other types of process equipment have many design variables. Matching equipment production capacity to the users requirement and spatial limitations are the starting points of most projects. In baking generally both brick oven and electric oven can be used to bake and at the end attain acceptable results, but construction materials may bring about the distinct variation in their finished products. These variations may be in terms of quality, taste or Odor

#### 1.6 **SCOPE OF STUDY**

Both ovens will be fired to a particular temperature that would suit the baking purpose, temperature in the brick oven will be measured using a thermometer since it does not have a temperature regulator.

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

#### 2.1 OVER VIEW OF OVENS

Since the creation of man, cooking has existed and it has been a way man use to spice and improve the quality and appearance of his food due to concept of choice. Man has had the ability to vary the appearance of his food, example of this is fish which could be eaten slightly smoked or dried. This same concept of choice led to the discovery of the oven. No one can be exact in predicating when the oven was discovered but one is not far from the truth in saying that the oven is as old as man himself.

The oven could be defined as a compartment or receptacle for baking or drying food items.(oxford 1984) As defined above the main function of the oven, basically is dry. To dry food stuff like fish and meat so as to preserve them. This was basically done by the early men and they fired their oven with the use of burning wood (char coal). But as time passed, technology evolved the oven from early man's form to the present day ovens. The basic function of the oven still remain the same with that of the early man but the variety of food items which are preserved by oven in creased rapidly, and also the time factor improved considerably. (Alan Scott 1951)

As time evolved technology improved the time and quality with which our food is prepared technology made it possible increasing the variety of food stuff that the oven can handle. Some of the basic functions the oven performs but which has not changed over the year are baking, roasting of food items, warming preheating food and grilling.( Wisegeek 1973).

For domestic, use, ovens have a minimum temperature of 30<sup>0</sup>C to the maximum of 250<sup>0</sup>C (the temperature varies depending on manufacturer's choice). Ovens that operate at temperature above 1200 650<sup>0</sup>C) are referred to furnaces. One can summarize therefore that, the types of oven that exist are

- Domestic ovens: operates between a (temperature of 0<sup>0</sup>C to 300)
- Industrial ovens: operates at a temperature of 800<sup>0</sup>F (430<sup>0</sup>C) and heating is by forced convection.
- Furnace: Operates at elevated temperature up to about 1000<sup>0</sup>f  $\approx$  430<sup>0</sup>C) and at temperature as low as 250<sup>0</sup>F ( 120<sup>0</sup>C)
- Microwave oven: this operates within the electromagnetic spectrum( Summer Rights 1990)

## 2.2 HISTORY OF BRICK OVEN

Over the years: breads were baked in an oven which was a kind of small igloo built with domestic dirt inside the home or outdoors. Because of the flatter bread usually made in middle east countries, dirt oven baking is different than French and Italian brick ovens for instance the main benefit of the brick oven is that the fire is burning slowly and for about 2hrs (depending the size) over the brick or stone the heat is accumulated and scattered homogenously for a long time inside the cavity called (sole chauffage direct) meaning direct heating baking surface.(Pomoeli 1972) It is heated a day before starting to bake bread properly if the oven is new or used once in a while. Good bread requires time, once the space is very hot the embers are removed and the space is cleaned with a wet cloth then the oven; door is looked and the heat spreads until the oven's archway becomes white the old fashioned way to check the temperatures was to throw a piece of



newspaper ball inside the oven's centre stone then wait 3 minutes, if the paper was brown and almost burnt the oven was hot enough.(Forgazzos 1974). The leavened bread needs to be seized by the heat from the fire bricks of stones and baked at a decreasing heat ( cuire a chaleur tombante) if the oven is used daily the time of heat would be reduced.

This days ovens were built on stones and clay and fire being buried inside them, at the early 18<sup>th</sup> century ovens were road built with chimney and differences in sizes of ovens were made wood was the major fuel then because its plentiful and cheap which contended until the introduction of other fuel like coal.(Frankie et al 1980) and as time went by the introduction of felled ovens with dampers to carry away smoke was made at the end of the 18<sup>th</sup> century which saved problem of removing ashes from the oven.

Before the 19<sup>th</sup> century when the individual ovens weren't yet built villagers baked their bread in the main plaza oven called "four banal" specific marks were made on some fine piece of dough for identification after baking.(Lepanyol 1981) This custom is still currently observed actually. Later to avoid hard labour required by those steps, some oven makers have created another kind of oven indirectly heated (sole chauffage indirect) meaning that the wood burning is placed below the baking surface with an air duct aperture that is called a (guelard) a metal tube vacuums the flame through it and heats up the entire archway and baking surface at the same time the main advantage is to avoid the embers over the baked surface. The embers are removed differently through a door usually placed on the ovens bottom or sometimes on its side making bakers safer and reducing the labor at the same time was welcomed. Today some old fashioned French baker companies use a wood burning brick oven like it used to be at the beginning of the 19<sup>th</sup> century.(Dvoraks 1979)

Among the firebricks specialist, Spanish and Italian ovens makers seem to have more experience. Italian pizza oven is designed differently and not realistically allow baking bread safely. This comes from the door issue because of the chimney is placed further inside and the door needs to be looked during the baking process. Where bread can be baked properly, all kind of dishes and pastries will be too. However pizza and some dishes require flame on side with an unlocked door. The outdoors home stone ovens can be inspired easily from the professional way. The biggest stone oven is composed of a 3 inch ( 8cm) thick revolving round stone deck baking surface can measure 2.5 sq ft ( 21.5m<sup>2</sup>) weighed over 68,000 pounds ( 30.00<sup>0</sup> kilograms/30 tones) the heaviest fixed baking surface weights 220,000Lbs (100.000kg/100tones) the benefit from the advanced technology revolving round stone makes sense during the baking process because each piece of bread that you put in the oven turns slowly. As you conserved the heat the wheel turns a little at a time. At the end of the last quarter circles of the stone when the oven is full of bread, the first bread should be baked like baguette, bigger size of bread will take more time. This is efficient and practical and requires a quick pace. Other stone ovens work differently depending on the bakers abilities and preferences about it.

Another interesting benefit when you used wood for the baking process is usually lack of control by taxes because of the difficulty to make a ratio utility between quantities required of wood, water and bread baked ( [www. Chefno.com](http://www.Chefno.com)) to complicate the process makes combine electricity and gas or wood or only electricity or gas the economic advantage when you have a heavy well insolated volcanic stone oven is that you keep the heat for a long period to save electricity. The oven can be turned on at night and then be off when bread is ready to bake during the day. Electricity is cheaper at night in France.

This system is useful for all companies to avoid massive consumption quality leavened bread requires fire bricks or stones but not necessarily wood heat. Some baker do believe that wood gives a better flavour customers are lured by this appealing concept of wood fired products. Pizza or other recipes which are usually baked with close embers and flame can be actually enhanced by wood smoke from dried vines and stumps. However, bread by itself should not be baked with any ember remains inside of the baking surface because the bread burn. Some people who make their own bread or pizza use an inch thick square stone and put it in the middle of the kitchen oven and bake the bread directly over it and throw some ice cubes or water spray against the hot oven's edges to get steam. The steam gives a nicer brown and glossy colour and makes bread crunchy. culinary historians credit the greeks for developing bread baking in to an art they created a wide variety of dough's loaf shapes and styles of serving bread with other foods baking developed as a trade and profession as bread in reasingly was prepared out side of the family home by specially it rained workers. This is one of the oldest forms of professional food processing.

### **2.3 DESCRIPTION OF BRICK OVEN**

Brick oven can be described as a barrel vault it has also been called a letter box oven, because the shape resemble a rural letter box.(Artigiono 1985). The foot print is rectangular and the dome is a curved vault or barrel vault that looks much like a gothic cathedral, these oven style which are large commercial ovens are used for large scale bread bakers. Thermal mass of the oven result in oven heat up cycles. This oven type can be constructed using some materials designed to withstand heat and high temperature these materials may be referred to as refractories. These construction materials are:

1. **Brick:** in constructing this type of oven it is recommended that high quality fire brick may be used for the floor and dome of the oven. Red clay brick are a traditional design element for many oven finish styles.
2. **Clay Bricks:** red clay bricks may not be recommended for the dome of floor of the oven they are on the other hand beautiful and very in- expensive as a finish materials.(Valantine 1993)
3. **Concrete Block:** these 8"x8x16' blocks are easy to use and inexpensive for building an oven stand except for builders who need a faster or lighter installation method then a metal hearth tray and stand should be considered.
4. **Door:** there are a number of oven door design including a free standing sheet metal door, a hinged and insulated door, or an owner built wood door you use the oven door to regulate air in-take and strength of your fir in retained heat cooking
5. **Fire Brick:** this a refractory brick used to build the done of the oven, typically made about 30% Aumina and 60% silica, they can withstand papid heat-up and cool- down cycles without spalling ( flaking) of cracking.(Cindy mushets 1989)
6. **Fire clay mortar:-** This is a mortar made for building the oven that consist of stand, fireclay and Portland cement, though not as resistant as true refractory mortar which is often easier to find. Mortar can be of three types at least for the purpose of installing an oven or any refractory fire place. Refractory mortar, a premixed heat resistant mortar engineered for ovens a site mixed mortar based

on sand and standard masonry mortar. It is advised not to use standard mortar for chamber and vent, use it for places that do not get hot during construction the following should be taken note of

#### 2.4 CONSTRUCTION PROCESS ( BRICK OVEN)

- a. **FOUNDATION:** oven should sit on a standard concrete pad, make sure you build your foundation slightly larger than your oven stand in order to support your finish materials consider sloping the foundation just slightly to the front of the oven; to keep water from standing in your wood storage area your hearth and oven floor will be level.(Forno Bravo 1991)
- b. **OVEN LANDING:** - area in front of oven where you place food in and out of the oven often the size and materials of the oven landing is up to the design of the owner, and ranges between 4"and 24".(Sheila mills 1991)
- c. **OVEN DOME:** The parabolic round shape of the dome is efficient with wood fuel and evenly reflects heat back down on the oven floor for cooking and baking dishes and bread that use both top and bottom heat for cooking. Its parabolic round nature should be put in mind during construction.(Forno Bravo 1992)
- d. **OVEN FLOOR:** the floor is made of bricks arranged to take the shape of the landing of the oven and mortar may be used to cove the arranged bricks for there to be a level and smooth surface.
- f. **OVEN OPENING:-** this is the door into your oven chamber. The size of the opening should be constructed in such a way that it s largeness can accommodate pots, pans, or grills without being so large that the oven does not hold heat.(Alan Scott1995).

**OVEN CURING:** - After oven has been constructed, it needs to be brought up to heat slowly to allow the oven itself and the installation/construction materials to dry. Failure to do this could result in damage to your oven. 'Preferably oven should at least sit for seven days after construction, then begin a series of seven small, then growing fires.

## 2.5 TYPE OF BRICK OVEN

1. **Cart brick ovens:** cart ovens are prevalent in and around Naples where they are used for catering parties and outdoor festivals (of which there are a lot) and for neighborhood entertaining. It can also be described as any portable or mobile pizza oven, that is used for catering events, parties or festivals.(Pompeli 1994)
2. **Commercial pizza bread oven:** commercial pizza ovens and residential pizza ovens are based on the same basic design, where the only differences are the size of the oven, the thickness of the refractory materials used and the quality of the refractory material used, for examples For no Bravo residential ovens ranging from "31-43", and commercial ovens ranging from 43"-72" while the walls of the commercial ovens is thicker it is important to note that the materials are the same. This is critical commercial oven is not recommended in a residential setting they cost more take longer to heat up and used more fuel than residential models; and are designed to be fired 24/7, 365 days per year for 15 years.
3. **Pizza oven:-** a traditional round Italian wood fired oven optimized for cooking pizza roasts, vegetables and a single batch of bread from a single firing sometimes features an LP fixture for back up and fire starting.(El\_Badri 1992)
4. **Residential pizza oven:** residential pizza oven are both designed for home and garden use, and have a number of defining characteristics. They are smaller in

size and are slightly lighter in weight, their lower thermal mass and high tech refractory material enable them to heat up very quickly typically between 40 and 60 minutes making it practical to use them often during the week.(Alan Scott 1994)

5. **Tuscan oven:-** this features a slightly higher oven dome and less aggressive inward slope than the Neapolitan oven. It is said to excel at baking that said, the styles are very similar in the bigger scheme and cook very similarly.(Noailles 1999)
6. **Wall oven:-** This is a pizza oven set behind a partition wall either indoor or outdoor
7. **Igloo:-** this is a form of outdoor or indoor pizza oven enclosure where the oven walls follow the basic shape of the oven chamber to form an igloo or beehive and it has a traditional Mediterranean finish style.
8. **Barrel vault:-** this is known as a brick bread oven and this style has also been called a letter box oven. The foot print of this oven is rectangular and the dome is a curved vault. You see this oven in French and Scottish bread ovens ( which are large commercial ovens) this style of oven works well for large scale bread ovens. It is a poor choice for either home brick oven owners or pizzerias. The thermal mass of the oven result in long oven heat up cycles and poor fuel economy and the shape is not suited for fire in the oven cooking and pizza .(Forno Bravo 1998)

## 2.6. **MODE OF USAGE OF BRICK OVEN AND CONTROL OF HEAT.**

Brick ovens are being fired some hours before baking commences this is done inside of the baking chamber with the oven door left open for flame and smoke to escape after some time when flame goes down the coal are scattered on the floor of the oven for heat to be retained at the bottom on the oven and after these the embers are raked outside the oven through the door and the space is cleaned with a wet oven brush then the oven

door is locked and heat spreads round the oven and after this bread can be baked in it.

Heat is been lost in this oven as the baker continues to bake due to opening of the oven door during loading and offloading. There the heat becomes difficult to control but can be controlled based on the result attained on the bread. Initial baking tends to give a good bake while second to third baking may be good but taking longer time than the first baking because of heat loss. When baking begins to be slow, down blow could be introduced to bring the heat back to temperature required by the baker.

## 2.7 CONVENTIONAL OVENS

Technology improved the time and quality with which our food is prepared due to the fact that baking developed as a trade and profession as bread increasingly was prepared outside of the family home by specially trained workers to be sold to the public. The conventional oven is a kitchen appliance and is used for roasting and heating. Food normally cooked in this manner includes meat, casseroles and baked goods such as bread, cake and other desserts. In the past cooking ovens were fueled by wood or coal. Modern ovens are fueled by gas or electricity (Hungry Howie 1999). Ovens usually use a variety of method to cook. The most common may be to heat the oven from below this is commonly used for roasting and baking. The oven may also be able to heat from the top to provide broiling. Convection oven used a small fan to blow hot air around the cooking chambers steam ovens introduce water in the form of steam into the cooking chamber. This can aid the formation of a crisp crust on baked goods and prevent the drying out of fish and casseroles. The degree of humidity is usually selectable among at least several steps. Some steam ovens use water carried to the oven by the user in a container; others are permanently connected to the building plumbing. More modern oven, such as general electric's



trvection oven, may also provide combined thermal and microwave cooking. This can greatly speed the cooking of certain types of food while maintaining the traditional characteristics of oven cooking such as browning. Conventional ovens have a simple thermostat which turns the oven on and off and selects the temperature at which it will operate(Alabama 19990). A timer may allow the oven to be turned on and off automatically at preset times more sophisticated ovens may have complex, computer based controls allowing a wide variety of operating modes and special features including the use of temperature probe to automatically shut the oven off when the food is completely cooked to the desired degree. Some ovens provide various aids to cleaning continuous cleaning ovens have the oven chamber coated with a catalytic surface that helps break down (oxidize) food splatters and spills over time self cleaning ovens use pyrolytic decomposition (extreme heat) to oxidize dirt. Steam ovens may provide a wet soak cycle to loosen dirt, allowing easier manual removal. In the absence of any special method, chemical oven cleaners are sometimes used or just old fashioned scrubbing (w.w.w.wikipedia)

Convection ovens or fan ovens or turbo ovens augment a traditional oven by circulating heated air using a fan. The fan motor is in a separate enclosure to keep from over heating. Food warms faster in a convection oven since the moving air strips the thin layer of air which otherwise would surround and insulate the food, technically, all ovens have natural convection currents which vary with food placement and the position of the heating elements, for this reason a more accurate term would be forced convection oven (Firenze 1991). The popular term "convection oven" could therefore be constructed as a shortened version of this more precise name by moving fast hot air past the food,

convection ovens can operate at a lower temperature than a standard convectional oven and yet cook food more quickly. The air circulation, or convection tends to eliminate hot spot and thus food may bake more evenly. An impingement pizza oven will have about a 50 degree Fahrenheit (30 degree Celsius) reduction in cooking temperature compared to a conventional oven. This comparison will vary, depending on factors including, for example, how much food is being cooked at once or if air flow is been restricted by using an over sized baking tray (Alkar 1999).

Many convection oven also include a proofing capability using the same fan but at a much lower temperature. A residential double oven will of ten include the fan capability in only one of the two ovens. (w.w.w.wikipedia)

Another form of convection oven is the commercial impingement oven. This type of oven is often used to cook pizzas in restaurants. Impingement ovens have a high flow rate of hot air from both above and below the food. The air flow is directed onto the food which usually passes through the oven on a conveyor belt. Air flow rates can range between 1-5m<sup>3</sup>/S. like the impingement oven. A convection oven usually has the radiant elements in view of the food, which improves heat transfer and speeds cooking from initial cold start. Some ovens have the heating elements placed in and outside enclosure and hidden from the food. This eliminates radiant heat from direct contact with the food.

## **2.8 TYPES OF CONVECTIONAL OVENS**

Hot air ovens: This ovens are externally heated by burning gas, oil or solid fuel the principle of heat is by hot convection current which circulate in flues and directs between the baking chamber. Most of these ovens are found with rotating dampers in the supply air ductwork are used to vary the supply air velocities. ovens with horizontal air flow

utilizes two fundamental air handling features, single main blower for total air mixing and rotating dampers for alternating air flow in the product zone. Horizontal air flow ovens are most beneficial when processing products that are loaded on screens or trays.

- **ELECTRIC OVENS:**

Here fuel cost is a factor that demands some consideration they are the most common and known oven mostly in countries served by cheap hydro electric power, which it operates with these ovens are highly efficient. All heat generated by the heater element is picked up by the recirculating air as it passes through the bank of tubular heater elements. Fins can be added to heater elements to increase heat transfer. Fin allows the heater element to run at a lower temperature which would extend their life, or fins would allow the designer to select a smaller heater element with higher watt density. These ovens are also designed with reduce air temperature rise to maintain a balance between equipment cost and operating cost. Equipment costs are more than direct gas because of the electrical heater elements and control components. An exception to this will be the smaller size oven where an electric system would be less expensive than a gas or steam system.

- **VIENNA OVENS.**

Vienna bread and rodle must be baked in a steam saturated atmosphere for this reason the Vienna oven is built on a different principle from the ordinary oven. Steam is lighter than air and it therefore rises, it is this fact that is the basis of the construction of this type of oven. Steam systems are indirect heat system and supply heat to the return air by passing the return air steam through steam coils. These coils are usually constructed of copper, cupro-nickel or stainless, tubes and copper of stainless steel fins. This oven is less efficient than a direct gas system coil construction is a major factor in heat transfer

rate Copper gives the best heat transfer (high thermal conductivity) and stainless heat provides less heat transfer (low thermal conductivity) the number of fins per inch and the fin materials will affect heat transfer capability. Tight fin spacing makes cleaning difficult and can result in coils being plugged with smoke tars. Too few fins will require a deeper coil (more rows) to provide an adequate amount of surface area for heat transfer. (Alkar 2002), normally provides coils with 6 fins per inch. A steam coil with 6 fins per inch provides 6.5 times more heat transfer than a bare tube coil of equal size. An all stainless steel coil is approximately 70% as effective as a copper fin and tube coil equipment cost are more than direct gas because of the steam coils and equipment design ( larger fan cabinet)

#### - **TRAVELLING OVENS**

They are far more economical to operate by the new systems of heating. This is done by recirculation of heater flue gasses. In this way the fuel is made to yield its maximum heat and losses are thus reduced most common equipment locations are on top of the oven cabinet or on the floor behind the oven. The oven is sized and configured to match oven size, space limitation heat source and process requirements (Howard et al 1992).

#### - **REAL OVENS:**

The oven can be fired by gas, electricity oil solid fuel, firing is internal with gas and electricity and the external on the hot air principles then using oil or solid fuel. The gas fired oven is fitted with an electronic flame failure control, an efficiency safety device which ensure that the gas is cut off immediately should the flame be accidentally extinguished the oven is heated gradually and the heat is remarkably flexible. With working temperature being easily and quickly attained. Gas steams are usually direct

heat or indirect heat. Direct heated system fire the gas burners flame directly into the return air stream and impart heat to the air by mixing with it. An indirect heated system fires the gas burners flame into a heat exchange device and the heat is imparted to the return air by heat transfer from the heat exchanger. Natural gas and liquid propane are the two most commonly used fuels for the gas burner (Howard et al 1992).

**Electric brick oven:** This type of oven has an electricity supply of 220V. made of reinforcing mesh cut up and placed in form. fire brick is set dry onto the foamed glass with compressive stress of 100 P.S it has two dowells is which are located as knock out plug where electric wires pass through a metal divider strip that separates slab into 2 pieces. The back and side walls are built with fire bricks set in thin bed of clay. The electric element is installed at ceiling coupled with a data acquisition system to record oven temperatures with 5 channel thermocouple interface. This oven is for intermittent use. Bread bakers apprentice (by Peter Reinhart 1989).

When oven is retired and turned off note that initial steep temperature drops as heat soaks from surface to inside of bricks and once brick are stabilized drop is very slow

## 2.9 ADVANTAGE AND DISADVANTAGES OF BOTH OVENS

### *Advantage of electric*

1. Even baking
2. Consistence is assured
3. Speed and air flow is fixed

### *Disadvantages of electric*

1. Expensive to operate in high volume operation
2. Cost of Maintenance is high

*Advantage of brick oven*

1. Cost less
2. Ease of cleaning
3. Stone holds heat on surface better than metal

*Disadvantage of brick oven*

1. Require more effort and experience
2. Drop in temperature as doors are opened and closed to insert, shuffle and remove bread
3. Preheating and cooling times are usually longer (Macrae R. Robinson 1993)

## **CHAPTER THREE**

### **3.0 MATERIALS AND METHODOLOGY**

#### **3.1 MATERIALS**

Materials used for this project are:

- a. Electric oven
- b. Brick oven
- c. Thermometer (mercury tip type)
- d. Measuring tape
- e. Weighing balance ( kgs.)
- f. Baking pans (Aluminum)
- g. Samples of dough.

#### **3.2 PRELIMINARY TEST ON SAMPLES OF DOUGH AND PANS**

To achieve the aims and objectives of this test which is the performance analysis of the efficiency of local brick oven and electric oven (steam tube type). Preliminary test on dough and pans were carried out and these test includes test for

- i. weight of dough 1(one) in kg
- ii. weight of dough 2(two) in kg
- iii. weight of aluminum pan for dough 1 (one) in kg
- iv. weight of aluminum pan for dough 2 (two) in kg
- v. Depth of aluminum pan for dough 1(one)
- vi. Depth of aluminum pan for dough 2 (two)

Samples of dough to be tested are made from wheat mixed with ingredients like sugar, water, egg, powder, nut, meg (grinded), Breadeen (Bakery fat), E.D.C, salt, milk,

yeast, and preservative mixed in a bakery at Malali Kaduna and baking test were carried out there.

### **3.3 METHOD OF FIRING OF EACH OVEN TO TEMPERATURE REQUIRED BAKE THE DOUGH.**

**Brick oven:** Wood which was set on fire immediately after dough was mixed, was scattered around the floor of the oven when flame was almost off after some couple of minutes. Embers were raked out and floor was cleaned using wet cloth. Oven was left closed and temperature was measured using a thermometer. Heat was allowed to escape until it dropped to initial baking temperature of 150<sup>0</sup>c. This is the standard heat used for daily baking in this bakery for both electric ovens and brick oven.

**Electric oven.:** Oven power supply was turned on and heating up of elements began in the baking chamber immediately via the steam tubes. Temperature rose from 0<sup>0</sup>c to 150<sup>0</sup>c which is the normal heat required for the baking. In this oven the temperature remained constant for all baking if electricity is made available.

### **3.4 METHODS OF COMPARISM (PERFORMANCE ANALYSIS)**

Temperature measurement was carried out with the aid of a thermometer.

Procedure: Test was carried out preliminarily for 2 samples of dough of different weights including 2 samples of Alumunium pans each one for each of dough weighed. Each of these dough was put in a brick oven and electric oven and time at which it was put was taken. Each was monitored for a period of time. The same test was carried out for the second dough which was lighter in weight with lighter and lesser aluminum pan weight and time of loading was taken. Note that in the brick oven during loading and offloading heat was loss and this caused a change in temperature and change in time at which



sample of dough was baked. Thermometer reading of heat before second baking in brick oven was 145<sup>0</sup>c while in electric oven it remained constant (150<sup>0</sup>c)

### 3.5 PERFORMANCE EVALUATION

The evaluation of the performance of these ovens was based on parameters like

- i. Comparism of baking time for each oven.
- ii. Heat retaining ability of each oven after repeated baking,
- iii. Storage durability after days for each product from each oven.

### 3.6 COMPARISM OF TASTE, ODOUR, COLOUR, TEXTURE OF BAKED PRODUCT FROM EACH OVEN:

From these test carried out and method used it may be seen that baking in each of this ovens will have a varying characteristic which may tend to affect the quality of result to be attained, based on the characteristics of each which it may affect has nothing to do with ingredients used in its manufacture are as follows

- i. General taste of products
- ii. Odour of the product
- iii. Colour of attained result from each oven
- iv. Texture
- v. Durability of the product

### 3.7 PHYSICAL ASSESSMENT

- i. **Flexibility of use:** from methods used for this assessment it could be deduced practically that one of the ovens may be more flexible than the other.
- ii. **Features of each oven:** each of the ovens possesses a feature which may be a distinguishing factor which it has over the- other. The electric oven is made up

of thermostat and temperature control meter which tells the baker or user the state of heat of the oven. Also absence of smoke and absence of charcoal may bring about neatness in the whole baking process.

- iii. **Psychological effect on users:** one amongst the two ovens in comparison may be found after this test to have psychological effects on users. This may be as a result of the differentiating feature which exist amongst the working principles guiding their use.

## **CHAPTER FOUR**

### **4.0 RESULTS AND DISCUSSION OF RESULTS**

#### **4.1 RESULTS**

The Duration for the study covers the period between 21<sup>st</sup> September to 27<sup>th</sup> September 2008. This cover the day the test annalsis commences until the day desired aim was achieved. That is from the preliminary test stage up to when simplest were are stored.

Tables 2-4 in appendices a-b shows the record of the temperature test and preliminary test of weight performance annalist, heat retaining ability of each oven.

#### **4.2 TASTE:**

The taste of the bread baked in electric oven was normal and that of the brick oven was normal for the first and second baking unit the third baking where additional heat source may be required which may be introduce by the burning of wood and there by bringing about smoke in the baking chamber which may affect the taste of the bread

#### **4.3 ODOUR**

The odour perceive while product was fully baking was a normal odour while in brick oven the odour may change after the second baking due to drop in temperature which will bring about introduction of more heat in the system by the burning more wood and this brings about smoke to affect the odour of the product.

#### **4.4 COLOUR**

From test carried out the result in attained in terms of colour was a good brown colour for the electric oven which for the brick oven initial baking was a good brown and the second baking had a mixed colour due to drop in temperature which is as a result of heat loss while loading and offloading.

#### 4.5 STORAGE:

After those test as been carried out each product from each oven was stored in a cooled and dry store where it was found out that all waves baking in the brick oven lasted larger then those once bark in the electric oven.

Table1: storage period of store product.

Product	Temperature (baking)	Weight	Electric oven (time)	Brick oven (time)	Storage period
Dough 1	150 <sup>0</sup> C	0.66kg	30mins	32mins	Electric bricks
Dough 2	150 <sup>0</sup> C	0.09kg	27mins	36mins	oven oven
					5days 6days

#### 4.6 RISING ABILITY

In the second baking in the brick oven the rising ability of the bough increase and this led to increase in size of the bread due to the drop in the temperature while in temperature the dough rise slightly and would have more weight.

#### 4.7 MONITORING TIME

Time at which broad become baked in electric oven was faster for dough one and two become of the steady temperature and a smaller door opening than the brick oven.

Heat retaining ability: the tendency of the electric oven retained a steady temperature for baking is higher than that of the brick oven because heat is supplied and controlled in the system via electricity while in the brick oven heat is been loss with

time as baking process continues. After the first offloading, decrease in temperature noticed and recorded was 5°c.

#### **4.8 TEXTURE**

In the electric oven the texture of product was found to be harder at the top and softer beneath while in the brick oven it was found to be moderate at the top and hard underneath with a very good brown colour for the initial baking and as baking continued the top of the bread baked were softer and underneath was found to be moderate.

#### **4.9 DISCUSSION OF RESULT.**

From tables 2-4 showing result for the analysis ran to verify the differences in these two ovens. The results shows that smaller waves with lesser weight tend to get baked on time that leaves of bigger sizes and weight would do. This fact is applicable to both ovens, but the varying factor is the time it will take each of the oven to produce result. Each oven temperature for initial baking was measured by time taken for each dough loaded in it gets baked starting with dough 1 for each oven which is bigger in size and heavier in weight. This was also repeated for dough 2 which has lesser pan weight of 0.2LBS compared to dough 1, smaller size and lighter in weight.

It was noticed that steady temperature was always recorded after each offloading from electric oven while in the brick oven after each loading and offloading temperature fluctuation was always noticed and this contributed to the changes noticed in colour of bread, also this fluctuation help the product in lasting longer when stored because lesser temperature was used for the baking.

At the end of the baking period, the comparison of the performance was tabulated in

Table 2.

Table 2: comparative performance between brick oven and electric oven.

S/N	Particulars	Brick oven	Electric oven
	Temperature of inner chambers	150 <sup>0</sup> c	150 <sup>0</sup> c
	Time taken for dough 1 to be baked	32 minutes	30 minutes
	Time taken for dough 2 to be baked	36 minutes	27 minutes
	Temperature fluctuation	fluctuation	No fluctuation
	Minimum temperature recorded after first baking	145 <sup>0</sup> c	150 <sup>0</sup> c
	Taste	normal for first and second baker	normal
	Odour	normal for first and second baker	normal
	Colour	good brown for First baking and Mixed colour for Second baking	good brown
	maximum number of storage days (produce stored at normal room Temperature)	6 days	5 days.
	Texture	Moderate at the top hard underneath with a good brown colour for initial baking and for second baking the top was softer and underneath was moderate	hard at the top and softer beneath

## CHAPTER FIVE

### 5.0 CONCLUSION AND RECOMMENDATION.

#### 5.1 CONCLUSION

The result of this research shows the performance of each oven which makes its use more efficient and reliable than the other without sacrificing the quality of the oven or its beauty. The test shows that the electric oven has more advantage than the brick oven but some of the characteristics of the brick oven just might make the difference in choosing an electric oven, this characteristic deals with the cost of installation, maintenance, construction materials and the source of energy. This entire factor makes the brick oven of more advantage in terms of cost, regardless of the test carried out it was also discovered that in the brick oven the fluctuation helps to reduce the amount of heat to bake bread. This count and help the product to last longer when stored based on the facts recorded, it is therefore concluded that the electric oven is efficient, reliable and efficient while the brick oven is more economical, reliable and durable and easier to maintain.

#### 5.2 RECOMMENDATIONS

It is necessary to carry out this project work for a longer period of time so that it covers the two seasons of the year (dry & wet season) because the wet season tends not to help the heat retention ability of the brick oven. Government should assist this project work financially for it going to be carried out for a longer period of time. Cost of making a brick oven is far cheaper than installing an electric oven because the construction materials are cheaper, durable, available, reliable.

It is recommended that for any baker to make use of the electric oven he should consider the cost of electricity and its consistency. Otherwise a brick oven is

recommended for every baker via this research carried out.

In view of the recommendation made on this research work further studies is also suggested to be carried out to bring about improvement at the stage at which this research work is brought to a stop.



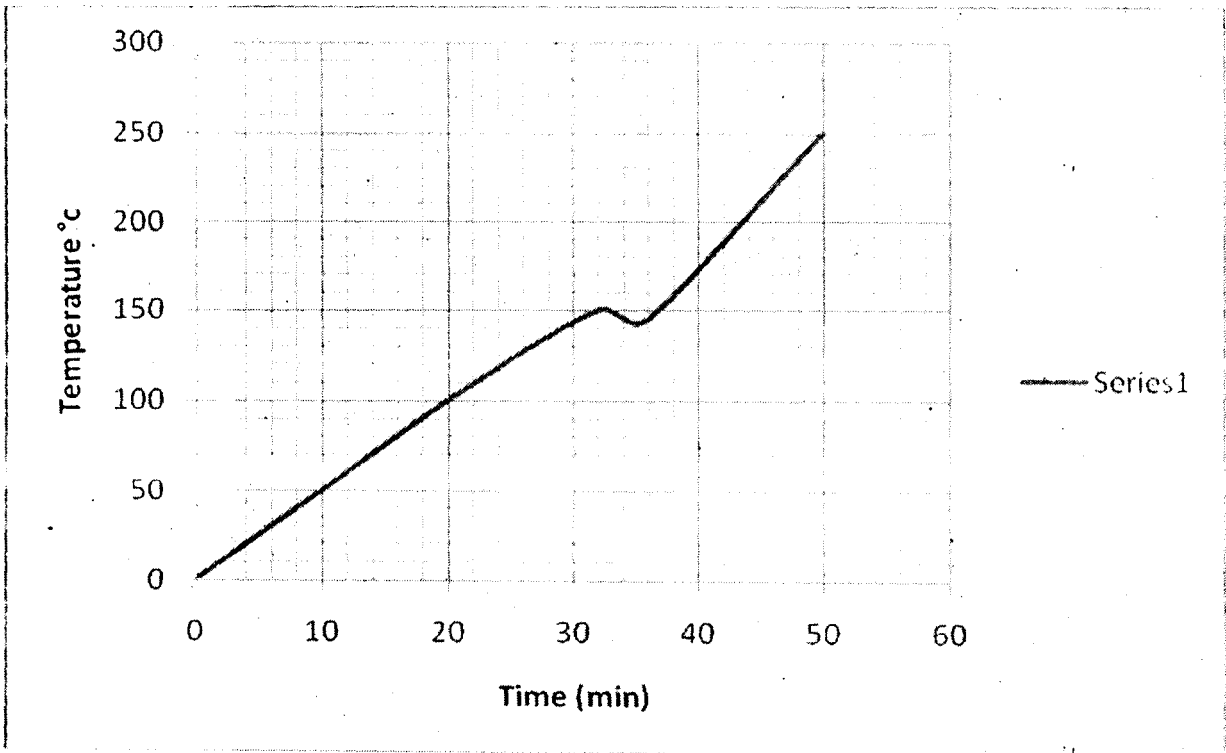


Fig 1: showing temperature for initial baking and its fluctuation in brick oven

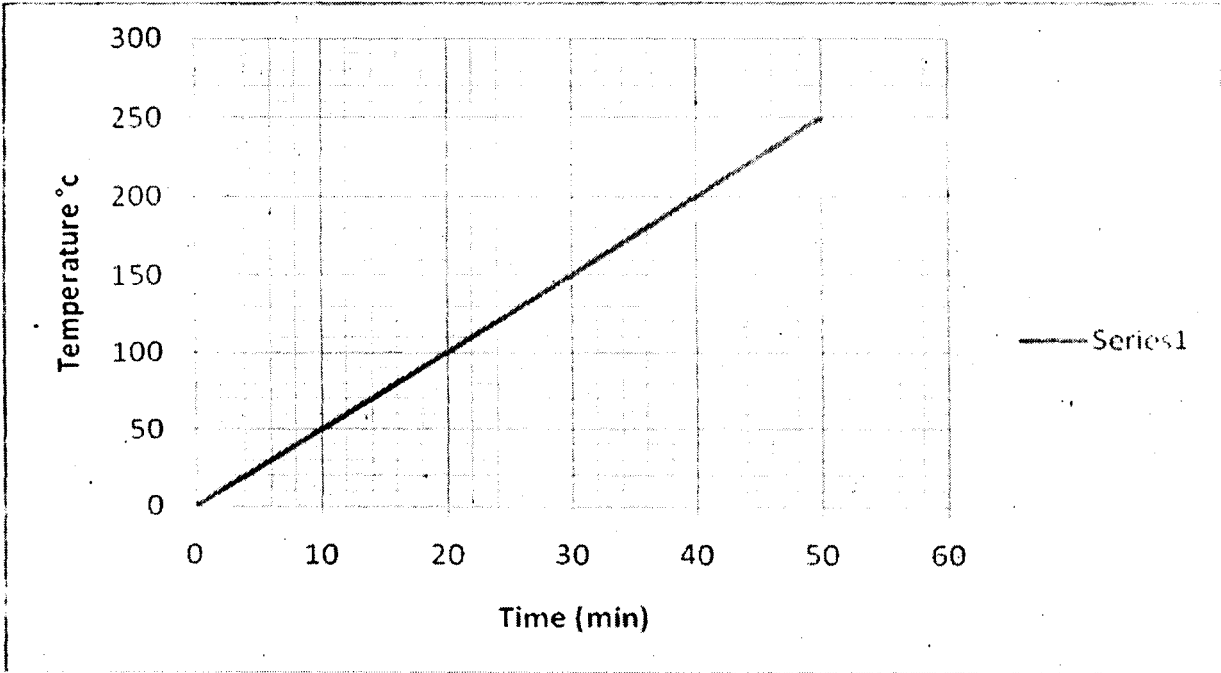


Fig 2: showing temperature for initial baking in electric oven for dough 1

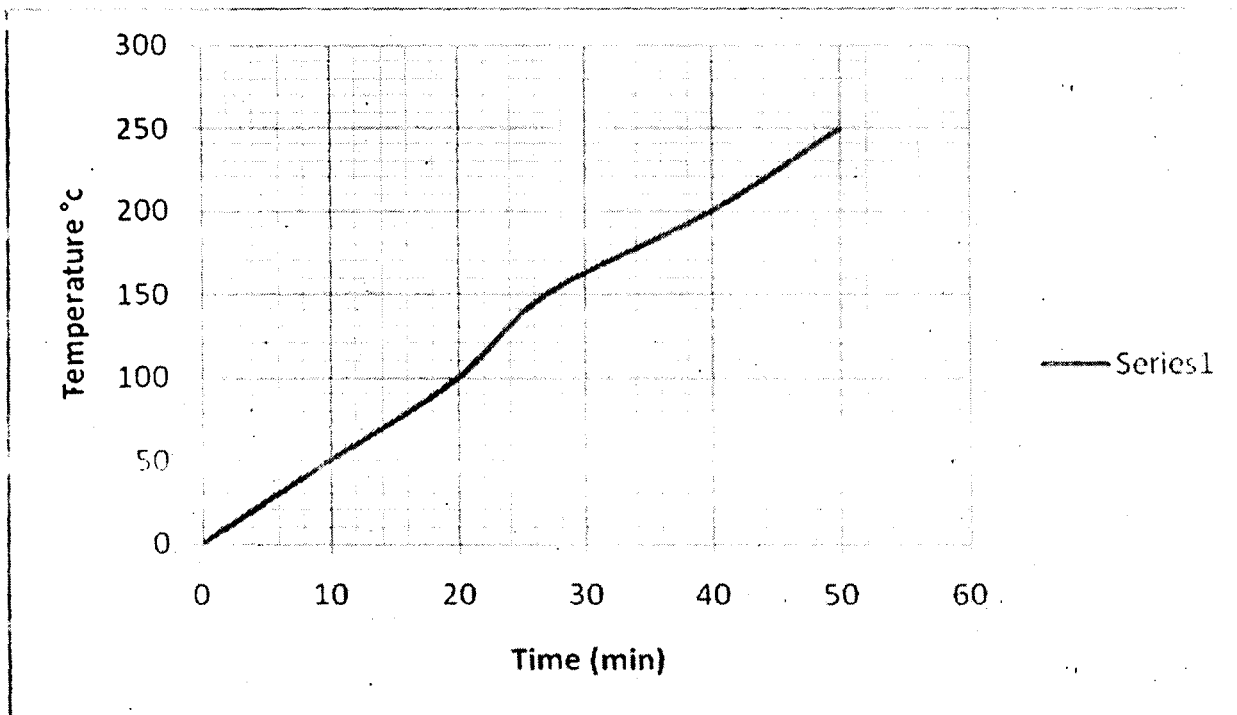
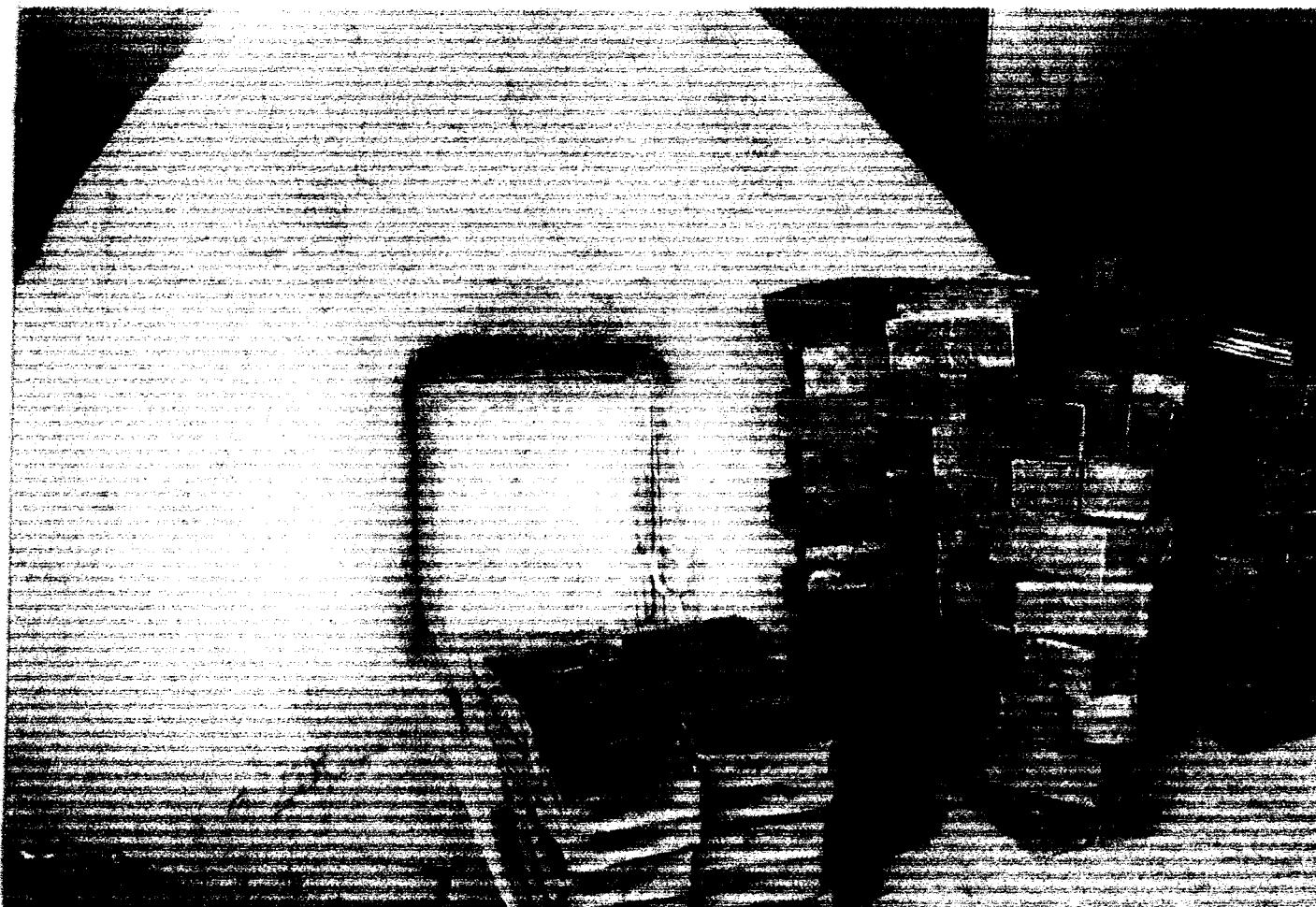
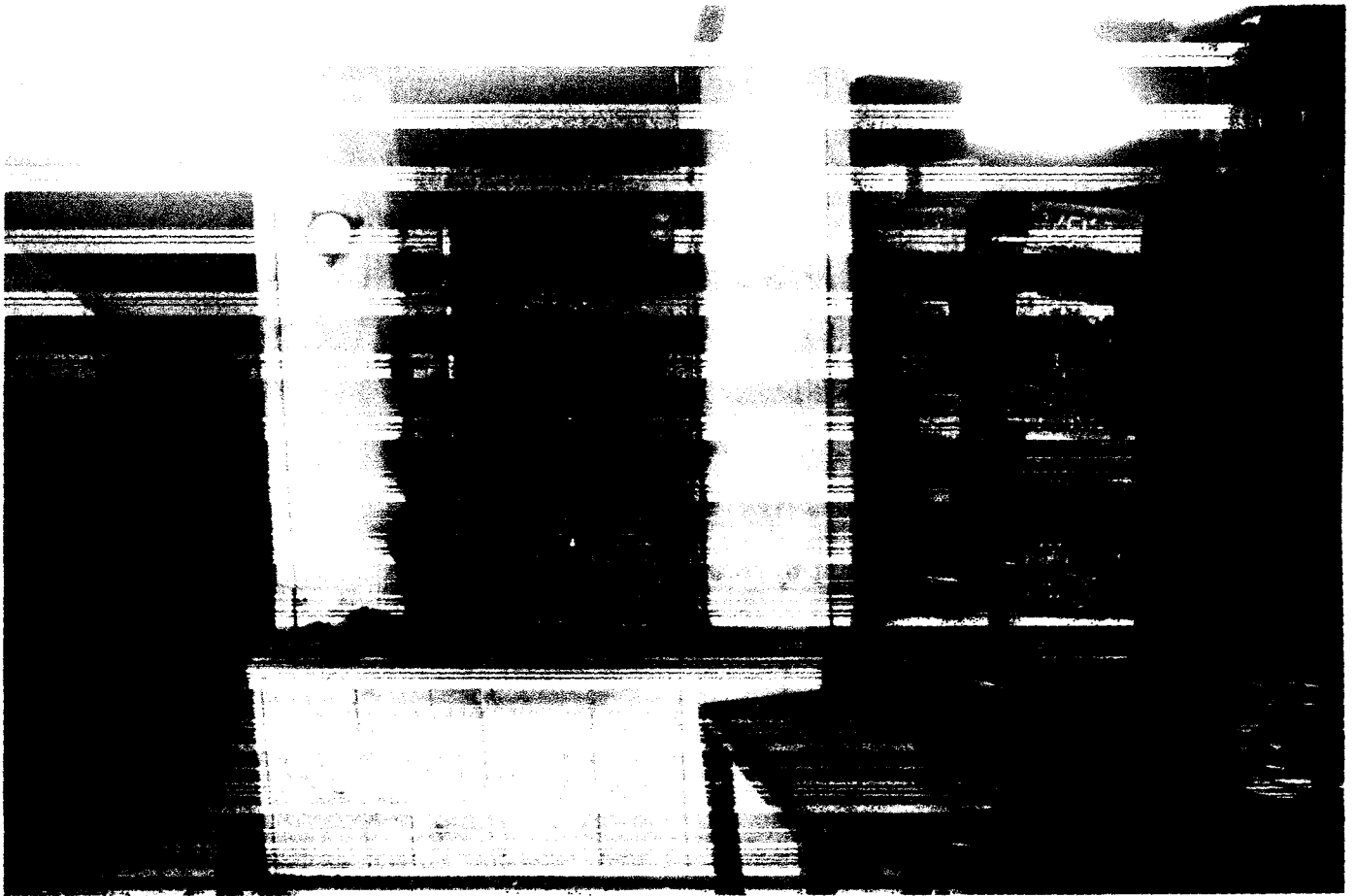


Fig 3: showing temperature curve for second baking in Electric oven for dough 2



**PLATE 1: PICTURE OF A FULLY LOADED BRICK OVEN**



**PLATE 2: PICTURE OF A FULLY LOADED ELECTRIC OVEN**

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## APPENDIX A

**Table 3:**

Weight	Figure	Difference	Effect of size
Weight Of Dough (1)	0.66kg	0.57kg	Size of Dough has an effect on the time it will take for it to be baked. The bigger it is the more time it will take
Weight Of Dough (2)	0.09kg		
Weigh of Pan For Dough (1)	0.265kg	0.008kg	Weight of pan's also a limiting factor which tends to increase or reduce the amount of heat to penetrate and touch the dough in it.
Weigh of Pan For Dough (2)	0.176kg		
Dept of pan for Dough (1)	0.11m	0.009kg	Most loaves tend to be moist at the centre this may be as result of inability of heat to penetrate due to depth. In this test all pan used were suitable.
Dept of pan for Dough (2)	0.09 m		

## APPENDIX B

**Table 4:**

Storage days	Standard temperature	Brick oven (wood)	Electric oven (electric)	Time Dough (1)	Time Dough (2)	Difference
	150 <sup>0</sup> C	150 <sup>0</sup> C	150 <sup>0</sup> C	Electric 30mins	Electric 27mins	3minute And 1.3Lbs
	-	145 <sup>0</sup> C	-	Brick 32mins	Brick 36mins	Temp Drop of 5 <sup>0</sup> C & 4 minute difference
Sun	-	Good	Good			
Mon	-	Good	Good			
Tue	-	Good	Good			
Wes	-	Good	Hard			
Thus	-	Good	Slight Change			
Fri	-	Slight Change	Bad			
Sat	-	Bad				



## APPENDIX C

Table 5 showing values for temperature curve for fig 1,2,3

BRICK OVEN			ELECTRIC OVEN	
Dough 1 <sup>st</sup> baking	150 <sup>0</sup>	32mins	150 <sup>0</sup> C	30 Mins
Dough 2 <sup>nd</sup> baking	145 <sup>0</sup>	36mins	150 <sup>0</sup> C	25 Mins

**TEMPERATURE OF BRICK OVEN & ELECTRIC OVEN DISCRPTION 0F RESULT**

Thermometer test for baking

Dough 1: 5lbs 150<sup>0</sup>c(brick)

Significant

Dough 1:5lbs 1 50<sup>0</sup>c(electric)

difference in time

Thermometer test for baking

Dough 2 0.2lbs 1450<sup>0</sup>c (brick)

Significant difference in

Dough 2 0.2lbs 150<sup>0</sup>c (electric)

Temperature and time

Storage of each product

Dough 1 and 2 of (brick)

maximum of 6 days.

Dough 1 and 2 of (electric)

maximum of 5days;