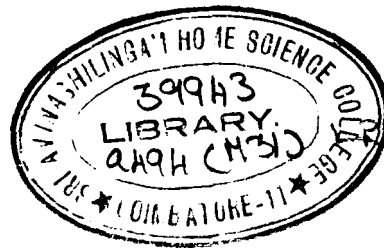


DESIGNING AND EVALUATING A LOW
COST NONELECTRICAL BAKING OVEN

By

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I. INTRODUCTION

Home management implies making the best use of the available material and human resources to derive the best values and to conserve time, energy, money, space and labour. According to Devadas (1968) management is the key to success in homemaking. Good management demands that everyday household tasks be performed with a reasonable amount of ease and efficiency - Report of American Public Health Association Committee on the Hygiene of Housing (1951).

Of the homemaking activities cooking involves tremendous amount of work demanding the major portion of the homemakers' time. This fact has been justified by the findings of the Directorate of Extension, Ministry of Food and Agriculture (1957) according to which homemakers spend nearly 70 per cent of their working time in the kitchen in various activities connected with cooking.

In order that cooking may be carried out satisfactorily with relative ease and efficiency, the kitchen must be provided with time and labour saving, safe, sanitary and convenient cooking equipment. Beveridge (1960) affirms that equipment is the product of the desire of people to find better and more effective ways of doing the work of the home.

Household facilities of effective type are not gadgets but essential factors in healthy living. To Justin and Rust (1953) and Johnston (1965) properly designed household equipment makes the house convenient and comfortable and facilitates the work by adding to its charm and beauty. The appliance affects the content of work as well as the worker's input. Smart and Smart (1958) view that the right kind of equipment is important for any job. A piece of equipment which we use often and which does what we want it to do is usually a good investment.

The traditional household skills have however been greatly changed by scientific discovery and invention. Attention has come to be focussed more and more during the past half century on ways of reducing the effort that goes into house work. Evidence is seen in the upswing in the invention and output of labour saving equipment.

The rapid technological advances of recent years have produced an increasing variety of equipment designed for the home. Annual changes in design and improvements in conventional items, new and different types of equipment and appliances to ease and change the routine of housekeeping are developed at frequent intervals.

Today, production lacks, unity of direction, unrelated to cultural factors and unsuitable to work practices. Investment on such appliances for families is not only a monetary waste but also a waste of human effort and time. All types of equipment if improperly designed involve not only physical strain but also sanitary and health hazards. A glimpse into the commercial world indicates that the quality of equipment currently being produced in the country is not satisfactory with regard to material used, design, construction and performance which causes frustration and fatigue for the user, the very antithesis of work simplification.

At a conference sponsored by the Ministry of Education, Government of India and the U.S. Technical Co-operation Mission to India for Home Scientists (1961) it was stated that a great deal of investigation is yet to be carried out to study the efficiency of existing equipment in India.

To suit almost all wet methods of cooking like boiling, steaming, stewing and some dry methods like frying we have equipment today within the financial means of average individuals but for baking - a low cost device seems to be lacking.

Among the well established commercial foods in use today "baked foods" rank relatively high. The reason for the same may be attributed to the lack of an effective

device for baking. Williams (1957) reports that baking presents great difficulties in places where there are no proper ovens. While every household may not be able to have a luxury model of an oven, the one selected should fulfil the features that make it effective, convenient and safe. The present investigation was thus directed towards the study of ovens available, their use in households and the construction and evaluation of a low cost non electrical baking oven.

It is hoped that the outcome of this study would aid both manufacturers and homemakers to some extent. To the manufacturers the same would be an addition to the non electrical brands, which are rare in the markets today; besides the use of all indigenous materials would ease the process and lower the cost of manufacturing. The consumers likewise would benefit since it would help them to understand the criteria to look for in purchasing an oven, and also help them to procure an efficient baking oven at a low cost.

II. REVIEW OF LITERATURE

The literature pertaining to this field of study has been reviewed under the following headings:

- A) Methods of cooking,
- B) Types of ovens,
- C) Materials used in ovens,
- D) Utensils used for oven cookery,
- E) Use and care of oven.
- and F) Selection of ovens.

A. Methods of Cooking:

Philip (1965) and Handa (1970) affirm that cooking does wonders to our foods. It makes them more tasty by bringing out new flavours and also improves their digestability and rids them of harmful bacteria. Cooking the right way saves the nutrients and destroys substances such as avidin and trypsin inhibitors which interfere with the utilisation of nutrients. Cooking also sterilizes the food.

The two major methods of cooking include the dry and wet methods. The latter includes boiling, par-boiling, steaming, stewing, simmering, braising and blanching. Dry methods include roasting, broiling, pan-broiling, baking and frying.

Wet methods:

Boiling: Barnes defines boiling as the method of cooking food in liquids usually water at the boiling point.

Par-boiling: Mitchell and Bernard (1954) cite that parboiling is cooking the food in boiling water until it is partially but not completely cooked.

Steaming: Philip (1965) opines that steaming is a method in which the food to be cooked is surrounded by plenty of steam from fast boiling water directly.

Stewing: Richardson and Callahan (1949) affirm that stewing is cooking for a long time using a small quantity of liquid.

Simmering: To Waldo (1967) simmering is cooking foods in liquids just below the boiling point.

Braising: According to Robinson (1967) braising is cooking over direct heat or in an oven with a small amount of liquid at a low temperature with the pan tightly covered.

Blanching: Barnes states that blanching is a method used to improve colour or reduce strong flavour of food stuffs.

Dry methods:

Roasting: In roasting the food to be cooked is brought in contact with the direct flame in front of a clear bright fire, Philip (1965)

Broiling: Robinson (1967) defines broiling as cooking by direct heat from a gas flame, electric wires or live coals.

Pan broiling: Heseltine and Dow (1947) regard pan broiling as cooking on a heated pan or griddle with little or no fat added.

Frying: The Concise Household Encyclopledia defines frying as cooking food in smoking hot fat or oil.

Baking: To Robinson (1967) baking is cooking in an oven using an open or covered pan. Baking is generally defined as cooking by dry heat. It is usually done in a closed oven where uniform temperature can be maintained and there is no need to turn the food constantly. The food to be cooked is surrounded by hot air and the action of dry heat is modified by the steam which arises from the food whilst cooking. Many of the foods which are deep fried can be baked with a little extra fat added to the dough.

B. Types of ovens:

Non electrical oven:

1. **Clay oven:** Dissanayake (1968) reports that a commoner type of clay oven used consists of a large mouthed clay pot filled with half to one third coarse sea or river sand. The mouth of the clay pot is covered with a flat clay vessel filled with live coals. Heat is applied to the pot and sand gets heated, this makes quite a satisfactory oven.
2. **Garri pot oven:** Williams (1957) describes this as a metal pot with a cover. Sand is filled in the pot and

it is heated. The food is put on stones placed on the sand which help to raise the pan from the hot sand. Hot burning coal is put on the top of the pot, so that there is heat under and over the food. The heat has to be increased or decreased as necessary during baking.

3. Brick oven: Joslin and Taylor (1963) point that these ovens are made of brick and heated by wood fires. When hot enough, the fire is withdrawn, the ashes swept out and the loaves put in their place. The bricks being bad conductors retain the heat and bake the product.

4. Anthill oven: Williams (1957) reports that this is the common oven made of ant hill clay used for commercial bread making. Fire is made in the oven and covered up to heat. The burnt ashes are then removed with a special long shovel. The oven must be really hot before the product is put in, as it is difficult to increase the heat once all the loaves are in.

5. Out door oven: The Department of State Agency for International Development (1962) suggests a different type of oven. An out door oven is very good for baking bread and other food stuffs. Adobe or bricks should be used for a dome shape with clay for plastering. The bricks are laid on the ground to make a base and after the base is laid, bricks are stacked into an oval shape. A front opening is made and a small hole is provided at the top of the oven to let out the smoke.

6. Cup-board oven: Williams (1957) cites that this is an ordinary cup-board lined with thick metal inside.

Instead of the wooden shelves, metal shelves are fixed and there is no bottom part to the oven. An ordinary coal fire is made in a pot inside the cup-board which is well closed to keep the heat in. If more heat is required, the hot coal in the coal pot may be reduced and the live coal may be put back in the cup-board to finish cooking the food.

7. Ovens made from kerosene cans: Two kerosene tins are fitted with lids. Fire is made between the two tins and the food put inside them. The fire heats the side of the tins nearest to it which conducts the heat to the other parts of the oven, eventually cooking the food. A hole should be opened for the smoke to pass through it. If possible a chimney fitted in, to take away the smoke.

8. Pastry oven: This oven is designed for baking only, states Walley (1958). According to the Modern Building Encyclopaedia (1955) this is specially adopted for pastry cooking in hotels and restaurants. It has a narrow clearance of approximately 9' between floor and top. This consists of three compartments with the external dimensions 56 x 66 x 47 inches (126 x 148½ x 105¾ cm).

9. Roasting oven: As described by the Modern Building Encyclopaedia (1955) the oven is specially designed for roasting, with rails at the top of the oven. Shelves are widely spread to allow for the roasting of joints. The external dimensions are usually $4\frac{1}{2} \times 2\frac{1}{2} \times 4\frac{1}{2}$ inches ($11\frac{1}{4} \times 6\frac{1}{4} \times 11\frac{1}{4}$ cm) with an internal capacity of 12.15 cu.feet. The time taken for an empty oven to rise to 250°F above room temperature is approximately 45 mins. Ovens of this type have obvious advantages where many large joints are to be cooked at the same time. The disadvantage lies in the operational difficulties of the shelves at the top of the oven and in the high fuel consumption if care is not exercised. The doors are very large so that if they are left open for more than the minimum amount of time necessary, considerable heat loss will occur.

10. The baker's oven: The Modern Building Encyclopaedia (1955) claims that this is specially adopted for baking bread. Although this very large oven is used in commercial bakeries, it is very rarely found in kitchens designed for catering only. The total baking area which is all in one level may be anything upto 100 Sq.ft.

11. Baker's steam oven: To Walley (1958) this is designed entirely for the baking of bread. The oven must first of all be exposed to an atmosphere of steam which cooks it on the outside leaving it soft and moist.

The process is completed by releasing the steam and allowing the product to cook in a dry atmosphere which gives it a crisp brown exterior.

12. Baker's oven heated by steam pipes: Walley (1958) exhorts that this oven is of interest because the method of heating is of a somewhat unusual and specialised type. Sealed tubes of $\frac{1}{4}$ inch (3.12 cm) diameter partially filled with water and tested to withstand pressures upto 750 lbs/sq. inch are filled in parallel rows in the ceiling and floor of an oven. One end of each tube is extended for some distance away from the oven and projects a few inches into the furnace.

13. Electric oven: Hammond (1963) indicates that an electric oven is heated by elements fixed behind the lining of the oven or sheathed in and plugged into place. They are usually arranged in the sides but occasionally in the top or bottom. Insulation should be heavy. Rock or glass wool or spun glass are commonly used. The oven door should be particularly well insulated and tight fitting. Oven units may be of open coil or encased tubular type. Heat is transferred by radiation and convection. A vent which should be adjustable preferably by hand is provided to carry off steam and vapours. It should be so located as to direct the ^ase way from walls to prevent discolouration. The thermostat insures automatic oven temperature regulation. Shelves should slide easily and lock to prevent tipping when drawn out.

Van Zante (1964) describes the range as a cooking appliance designed to perform baking, broiling, roasting and surface cooking operations. The ranges may be either of the free-standing or built-in type. The free standing range is most prevalent. It stands independently - a complete unit comprised of top burners or surface units, oven and broiler.

Built-in cooking tops and built-in ovens are incorporated into the house structure. A built-in cooking top is defined as a group of top-burners or surface units designed to be built into a counter top.

The rotisserie is used at the surface of the range, or in the oven, or in the broiler. A separate motor on 120-volt circuit is used to operate the rotisserie.

Parts of an electric oven:

Hand Book of Household Equipment Terminology (1967) describe the different parts of the oven as follows:

1. Oven door: Movable front part which opens to permit access to a range oven.
2. Oven shelf: A support for cooking utensils in an oven.
3. Oven baffle: A metal sheet which directly spreads heat throughout the oven.
4. Oven control: A switch which turns the oven on and off and by which bake, broil and other oven conditions may be selected.

5. Oven signal light: A light which indicates the oven is in operation or that it has reached the selected temperature or cooking is completed.
6. Oven thermostat: Automatic device that regulates oven temperature.
7. Oven window: Heat resistant glass through which contents of oven may be seen without opening the oven door.
8. Oven liner: Permanent or removable inner walls of an oven area.
9. Oven door gasket: Strip of resilient material around the oven or broiler opening or around the door itself to provide a tight door seal and to prevent heat loss.
10. Oven preheat time : Time required for oven heat to reach a preselected temperature from room temperature.
11. Oven temperature: Degree of heat within an oven.
14. Gas oven: Department of Food Economics and Nutrition School of Home Economics (1947) classify the gas ovens as semidirect, circulatory and fresh air type.

The Semi direct oven has a burner under a bottom or baffle plate with no flues to direct circulation. The circulatory type has flues to direct gas and air currents. An outlet is provided at the top or bottom of the back wall. The fresh air type is heated by fresh air warmed before entering the oven and combustion products

pass out through a vent at the top of the oven. This vent may be connected with a chimney or with a flue director to carry fumes and grease away from the wall.

Peet (1958) mentions that in the gas oven the burner is below the oven bottom which is cut away at the corners or sides, so that the currents of heated air may circulate freely. The lining of gas oven is usually made of porcelain enamel and steel and this is durable, does not discolour or stain easily and withstands high temperature.

15. Time controlled oven: To Hammond (1963) this is a modern development of a gas or electric cooker to help the cook ^{prepare} a meal. In her absence the oven will be lit at a pre-arranged time and thermostat setting. It will cook the food for a set time and then switch off. The automatic timing device consists of an electric clock work device which can be set to control the required delay before cooking shall begin.

C. Materials used in oven utensils:

Johnston (1965) affirms that heat is transferred in the oven by convection currents, conduction and radiation, since conduction is particularly important, the materials used in oven utensils should absorb heat

readily. The ability of the material to utilize heat therefore affects cooking efficiency.

The materials commonly used in the oven utensils are the following:

1. Aluminium: Beveridge (1963) cites that aluminium is a good conductor of heat and electricity and it does not rust. It is inexpensive, colourful, light in weight and durable. It tends to reflect radiant heat. Foods baked in aluminium are less apt to burn and bake more slowly and consequently, rise to a greater volume. It has a low melting point.
2. Iron: Iron is a good absorber and conductor of heat. Because of its dark colour it retains heat well. This is heavy and will rust if not cared for. It is brittle and will corrode.
3. Tinned steel: It is light in weight and is graded according to the thickness and quality of the base plate of the steel and of the tin coat. It is affected by food acids and it darkens with use hence the absorption of radiant heat changes rapidly.
4. Earthenware and heat proof china: These are clay products which are opaque, comparatively coarse in texture and porous when fractured. They are little affected by food acids and alkalies or by sudden changes in temperature.

Insulating materials: Van Zante (1964) believes that insulating materials are generally used to prevent the escape of heat, electricity or both. A good insulating material must not pick up moisture because water is a good conductor of both heat and electricity.

Peet and Thye (1965) conceives that insulating materials are commonly used in home equipment to keep the heat. The ideal insulation should not burn. It would be light in weight and it would be unaffected by mold, bacteria and insects.

1. Mica: Johnston (1965) opines that it is a fairly good conductor of heat but a poor conductor of electricity and these two properties make it adaptable as an insulator in electric heating appliances. It is soft, flexible and elastic but strong.
2. Mineral wool: Ehrenkranz and Inman (1958) affirm that it is durable and chemically stable. It will not burn, deteriorate or attract vermin or mice. It is not moisture proof unless especially treated.
3. Fibre glass: Johnston (1965) feels that it is flexible, non combustible, does not absorb moisture, has high tensile strength and will not mildew, rust or rot. Fibre glass bats are mainly used for insulation in ranges.

4. Asbestos: To Ehrenkranz and Inman (1958) it is light in weight, non combustible and has high resisting qualities. It is not moisture proof however unless especially treated.

D. Utensils Used for Oven Cookery:

According to Van Zante (1964) pans used for baking are lighter in weight and less sturdy than those used for top of the range cooking shiny oven utensils reflect heat and thus prevent browning. Black materials absorb radiant heat and increase browning.

Oerke (1960) reports that pans for use in the oven seldom get the hard wear that range top pans do, therefore light weight materials are generally used.

Oven pans should be strong enough to remain flat on the bottom and hold their shape. Construction as well as weight of material affects durability. The quality of the baked product is very much influenced by the material and finish of the pan.

Utensils for the oven cookery include the following:

1. Cake pans: Baking utensils like cake pans are round, square or rectangular. Fitzsimmons and White (1958) state that these pans are made of many materials. Bright aluminium and tin give a tender light brown crust.

Peet and Thye (1965) suggest that rounded corners and edges make for ease of cleaning. The manufacturers of pyrex glass recommend for the cake pans a temperature of 25°F lower than that used for other materials. Round pans are 8, 9 or 10 inches (20 x 22½ x 25 cm) on a side. Dimensions of rectangular pans are 10 x 6 x 1½ inch (25 x 15 x 3¾ cm).

2. Pie pans:

Fitzsimmons and White (1958) report that these pie pans are used for baking individual pies or tarts. These are round, open utensils with flared sides. These are measured by the inside top diameter. Common sizes are 8, 9 and 10 inches (20 x 22½ x 25 cm). These are made of aluminium, tin, glass or anodized aluminium.

3. Loaf pans: It is a deep, narrow, rectangular utensil with slightly flared sides, designed for oven use. These are used for yeast breads, quick breads and certain types of cakes. These are made of glass, aluminium and tin. Standard sizes include 11 x 7 x 3 inches (27½ x 17½ x 7½ cm).

4. Muffin pans: These may be used for rolls, muffins and cup-cakes. Muffin pans are tray like utensils containing a number of suspended individual cups which are almost straight sided and which are an integral part of the pan. Aluminium and tin were the usual materials. These are atbest hard to clean.

5. **Cookie sheets:** It is a flat rectangular utensil which may be open on one, two or three sides. It is especially designed for baking cookies, biscuits and creampuffs. These are made of aluminium, tin or stainless steel. Standard sizes are 14 x 10 inch (35 x 25 cm).

6. **Custard cups:** These are small, deep individual bowl shaped utensils especially designed for oven use. These are usually made of glass or pottery. These have many uses. Baked custard rolls are made in them.

7. **Casseroles :** This is a convenient and useful baking utensil. It can be used for main dishes as well as desserts. It is important that a casserole has a cover that fits well and a handle easily grasped. Materials used in casseroles should be those that retain heat when the casserole is brought to the table. Glass, pottery and earthenware are most suitable for this type of cooking vessel.

8. **Roasters:** A roaster can be a covered or uncovered pan with or without a rack. Lowe (1955) found out that cooking losses are less and food is more palatable when the uncovered roaster is used. Roasters are oval, rectangular or round. These are made of aluminium iron, steel or enamelware. Standard sizes are 14 x 10 x 2 inch (35 x 25 x 5 cm).

9. Aluminium foil: It is widely used for cooking, baking, food storage and food freezing.

10. Cake cooling racks: These are made of heavy wire and these are used for cooling baked products.

11. Baking sheets: Aluminium, sheet iron and tinned steel are the materials commonly used for baking sheets. Sheet iron will absorb heat more readily than tin and aluminium. Cookies, rolls and biscuits rise and brown more evenly when cooked on baking sheets rather than in pans.

12. Baking dishes: Any of the materials used for other types of pans may also be used for baking dishes.

E. Use and care of oven:

Several important factors are to be taken into consideration for successful baking. Seton (1963) asserts that time is one among the several important factors. The time for baking depends on: the size of the cake tin, the thickness of the cake tin, the size of the cake - whether large or small, the place in the oven - top, bottom or middle and the nature of the cake - plain, rich or sponge.

The Department of Foods and Nutrition, School of Home Economics (1956) reports that oven temperatures are very important for adequate baking. A convenient

classification is slow, moderate, hot and very hot.

The temperature may be indicated as follows:

Slow	-	250 - 350°F
Moderate	-	350 - 400°F
Hot	-	400 - 450°F
Very hot	-	450 - 500°F

Dissanayake (1968) and Downes (1957) suggest that the following rules are to be considered while baking:

The oven must always be preheated.

The oven door should as a rule be gently closed but never banged.

When baking is done, the oven door should not be opened until a specified period of time has passed.

The oven should never be over crowded.

To allow free circulation of air around, Hammond (1963) adds that baking trays should be of the right size, if other trays or tins are used they must not be very large as they will trap the heat, become over heated and burn the foods cooked on them. Ehrenkranz and Inman (1958) affirm that if only one pan is used place it if possible approximately in the centre of the oven. If several pans are used place them in such a way so that they will not touch each other or any part of the oven wall or door, also use a staggered

arrangement so that one pan is not located directly above another. Hammond (1963) points out that it is more economical to cook several dishes in the oven. Greer adds that for this it is necessary to select foods whose baking temperatures are the same or very nearly the same.

Oven doors should fit properly so that heat does not escape. One way of checking this is to observe the casing around the oven door after baking a few products. Every time the oven door is opened cool air is allowed to enter and this in itself changes the amount of time required for baking hence the door should not be opened frequently. A large sheet of aluminium foil should not be used in the oven as it will interfere with the circulation of heat.

Cake pans should be filled only about two thirds full, to prevent batter from running over the edge of the pan during baking. If there is too little, the product will be thin, poor in texture and not brown on top when baked to a standard length of time at a recommended temperature.

Many dishes are satisfactorily cooked starting in a cold oven. Most stewing may very well be done in the oven in casseroles as the rate of cooking can be controlled exactly. The base plate of the oven is suitable for slow cooking of stews even though the middle of the oven is moderately hot.

Good and regular maintenance will lengthen the life of domestic tools and ensure their efficiency. Barnes points out that the efficiency of the equipment largely depends upon the care given to it. Pollard et al (1969) opine that periodic thorough cleaning should supplement daily care.

Adams (1953) exhorts that the frequency of cleaning entirely depends upon the frequency of use and the purposes for which used. A bowl of ammonia kept in the oven helps to soften up grease and grime. The ammonia may be removed and the compartment scrubbed with hot water, soap, and detergent.

Pickford and Owen advise, switching off the oven before cleaning starts. Laitem and Miller (1954) suggests removing of the spilled food as the first step. Then the heating units should be taken out and set aside in a dry place. The inside of the broiling pan and rack need be washed whenever they are used. En^oameled surfaces should be washed with hot soapy water. Only when cool and wipe dry.

Coarse gritty scouring^{materials} should not be used on the enamel of the stove since it destroys the glaze.

Craig and Rush (1962) opine that when grease accumulates the oven will lose its efficiency and may smoke, clean top, bottom and sides of the oven regularly. Creese (1965) recommends the use of cleaners like scouring powder and nylon scourer prior to polishing with a clean dry cloth.

Editors of Good housekeeping (1956) suggest that household gloves should be worn while cleaning and special oven cleaners should be spread over all the crusted surfaces and the cleaner allowed to remain for two to three hours and the same rinsed thoroughly with sponge. News paper may be spread to protect the floor in front of the oven.

F. Selection of ovens:

Riggs (1967) points out that the key factor in the selection of equipment is the menu. The second factor to consider is the size and shape. The equipment that is selected should enable us to carry out our programme more effectively.

To Peet (1958) factors like the acceptance of certain standards or attitudes, the income of the family, the age, and size of the family and other needs of the family must also be taken into consideration.

Craig and Rush (1962) suggest that the model number, performance and other points must be noted, so that it may be possible to make exact price comparisons,

Directions for use, servicing and guarantee should also be taken into consideration. In selecting, comparisons should be made of the various brands and styles in terms of man power hours, production, capacity and cost. Installation costs must be noted.

III. EXPERIMENTAL PROCEDURE

The methods adopted to carry out the study consisted of the following steps:

- A. Household and shopping survey,
- B. Development of the design,
- and C. Evaluation of the device designed,

A. Household and shopping survey:

For both the household and shopping surveys, the following steps were undertaken:

- 1. Selection of the method,
- 2. Selection of the samples,
- 3. Conducting the survey,
- 4. Consolidating and analysing the data,
- and 5. Presentation of findings.

A survey as defined by Abrams (1951) is a fact finding study. It is essentially a method of collecting facts. Moser (1959) cites that the purpose of survey may be either to describe a problem or to explain it.

1. Selection of method:

The interview method was selected for the purpose of the study because of its convenience, comprehensiveness and the possibility of obtaining genuine information. This is substantiated by the statement of Rangaswamy (1969)

according to whom an interview method makes possible a face to face association and a process of interstimulation between the interviewer and the interviewee. Shukla and Gulshan (1970) regard that under this, data are collected by the investigator personally and therefore the inquiry is intensive rather than extensive. Jahodo et al (1951) add that the interview is considered more flexible than a questionnaire. Moreover it is effective and versatile with respect to the atmosphere which can be created during the measuring situation.

Interview schedules for both the household and shopping survey were prepared.

The household survey was conducted using the schedule as given in Appendix I. The following were the details elicited : brand name, cost, dimensions, materials used, year and place of purchase, guarantee, electricity consumption, temperature range, products prepared, time taken for preparing and methods of cleaning commonly adopted. The latter called for information on the different types of ovens commonly available, dimensions, materials used, cost, guarantee, electricity consumption, temperature range, details on name plate, trade mark and brand name. The schedule is as given in Appendix II.

2. Selection of samples:

Thirty households belonging to both the high and middle income groups possessing ovens were selected from R.S. Puram, Sivananda Colony, and Saibaba Colony. The sample for the shopping survey consisted of fifteen shops in Coimbatore city dealing with the equipment under study. Hence the sampling method chosen was purposive. As stated by Kenney and Keeping (1951) a purposive sample is one which is selected according to one or more definite criteria in the mind of the experimenter.

3. Conducting the survey:

Rapport was established by self introduction and explanation of the purpose for which the data was required. The survey was conducted by the investigator and details were collected pertaining to the equipment from the households and shops using the interview schedules.

4. Consolidating and analysing the data:

The data so collected were tabulated, classified and analysed.

5. Presentation of findings:

a. Household survey

The results of the household survey are tabulated and presented below:

1. Family background:

Hundred per cent of the families belonged to nuclear families. With regard to family size, 40 per cent had just three members in the family, 23 per cent - four members, 30 per cent - five members and a minority of seven per cent had six members.

As for the age group, 77 per cent of families had members in the age group (20-40) years, while 53, 50 and 40 per cent of the families had members in the age group (0-10), (11-20) and (40-60) years respectively and only a minority of families had members over 60 years of age.

Taking into consideration, the educational status of the homemakers, 60 per cent had college education, 37 per cent had high school qualification while the remaining three per cent had professional qualifications.

As regards the occupation of the head of the family, 70 per cent of the sample were in the professional group, 27 per cent in the business line and the remaining three per cent were agriculturists.

The income range of the samples - twentyseven per cent belonged to the middle income group and received an income between Rs. 601 - Rs. 1250 while the remaining 73 per cent belonged to the high income group earning

Rs. 1250 and above. The above mentioned classification conforms to that given by the Times of India (1971).

2. General information of the oven:

The different types of ovens possessed by the households are presented in the following Table:

TABLE I
TYPES OF OVENS USED IN THE HOUSEHOLDS

Percentage of families using	Indigenous brands			Percentage of families using	Imported brands (Automatic)
	Automatic	Non automatic	Non electrical		
20	Bajaj	--	--	7	Superspeed
3	--	Bajaj	--	3	Belling
7	Racold	--	--	3	Severin
10	Saratom	--	--	3	Russel hobbs
14	Homa	--	--	-	--
3	--	Rashmi	--	-	--
3	--	Amarjothi	--	-	--
14	--	Getco	--	-	--
7	--	--	Peacock	-	--
3	--	--	Guarantee	-	--

Indigenous brands were used by the majority of households among which Bajaj (automatic) proved to be most popular. Getco (non automatic) and Homa (automatic) ranked

next scoring 14 per cent each. A minority of three to seven per cent possessed imported brands.

None of the brands except Bajaj possessed a trade mark and model number. A guarantee period of one year was common for all, the same being given by the manufacturers. The ovens irrespective of the brands and shops were sold on a ready cash basis.

The difference in the cost of the ovens due to changes in sizes and brands are presented in the following Table.

TABLE II

COST OF OVENS IN RELATION TO SIZES AND BRANDS

Brand name	Cost in Rs.			
	Small	Medium	Big	Standard
<u>Indigenous:</u>				
<u>Electrical:</u>				
Bajaj	88	120	500	-
Amarjothi	-	110	-	-
Saratom	-	-	-	400
Getco	90	-	-	-
Rashmi	-	125	-	-
Homa	-	-	180	-
Racold	-	-	450	-
<u>Non electrical:</u>				
Peacock	-	-	90	-
Guarantee	-	-	-	25
<u>Imported:</u>				
Belling	-	-	-	1500
Superspeed	-	-	-	2500
Severin	-	200	-	-
Russel hobbs	-	-	400	-

It is obvious that special mention has to be made of the fact that a difference in cost was conspicuous although the sizes were identical in the case of the two brands Bajaj and Getco, where the cost for the former was Rs. 88 and the latter Rs. 90. Likewise similar differences were noted between the cost and size in the medium sized ovens for the brands-Bajaj, Amarjothi and Rashmi and the big sized ovens like Bajaj and Racold. The cost of the brands-Belling and Superspeed were relatively high as they were in the form of ranges.

Nearly 63 per cent of the homemakers surveyed had bought their ovens between the years 1960-69, while 27 per cent between 1970-71 and the remaining 10 per cent within the years 1950-59.

Materials used:

Aluminium was the metal mainly used for the indigenous electrical ovens and steel for the imported brands. For the accessory parts like door and handle, bakelite was common in all indigenous brands except Saratom where chromium was used. Only Racold had an insulation of fibre glass in between the two walls of the oven. Tin was the common material used for all non electrical ovens, for the accessory parts, wood was used.

Taking into consideration the special features of the oven: drip pan, drip tray, thermostat and signal light were found to be the common features in almost all the electrical brands while the oven gasket and oven baffle were found only in Saratom, Belling, Russel hobbs, Severin and Super speed, out of which Belling, Super speed and Russel hobbs were in the form of ranges. The non electrical ovens did not have any of these features.

3. Current and temperature:

Mostly all the electrical ovens worked under both AC and DC current. Irrespective of the sizes and brands, the wattages ranged from 650 to 1200 while the voltage ranged from 230 to 250. The baking temperature in general ranged from 120°F to 600°F.

Three switch positions namely low, medium and high of the rotary type was found to be common in all electrical ovens. Majority of the electrical brands had a separate fuse.

The preheating time for a majority of the electrical ovens was two to four minutes and for the non electrical ovens the range was from 10 to 15 minutes. Kerosene and charcoal were the fuels commonly used in the non electrical ovens. Ovens of the free-standing type were common.



With regard to the factors to be considered while purchasing, it was observed that majority of the households rated durability as the first factor of consideration followed by popularity of brand, availability and convenience in use. Cost occupied the fifth position in the list of priority.

4. Use and care of oven:

The use made of the oven by the homemakers are presented in the following Table.

TABLE III
PURPOSE AND FREQUENCY OF USE OF THE OVENS

Products prepared	Percentage of families preparing	Frequency of preparing	Percentage of families using
Cake	100	Daily	3
Biscuits	70	Weekly once	43
Biriyani	10	Monthly once	48
Stuffed products	10	Fortnightly	3
Pudding	3	Twice a week	3
Baked vegetables	3		

Cakes and biscuits were the products prepared by a majority of the families. Some of the homemakers prepared puddings and baked vegetables also. With regard to the

frequency of preparing, majority of the homemakers used the oven once a month while only a minority used daily or fortnightly.

Regarding the care of oven soap powder and vim were the detergents used by 70 and 30 per cent of the sample respectively.

5. Evaluation of the ovens:

The homemakers evaluation of the ovens possessed by them is as presented below.

The 11 electrical brands possessed by the sample were considered easy to operate, handle, and clean. These brands did not require constant attention and had a neat and trim appearance. These brands had a good heat retention capacity and provision for free circulation of heated air. All the brands except Super speed, and Russel hobbs were portable. These two were in the form of ranges.

As for the shelves, all the brands had sufficient number of removable shelves which had firm supports and sufficient baking area. The shelves were rust, grease and stain proof. All the brands had shelves which were resistant to decolorization, and were able to withstand high temperature. Provision for placing shelves at different levels were possible in the case of imported brands.

Only the imported brands had a locking device. All brands had doors which were lagged. In all, the handles were easy to grasp and made of heat resistant material. Except for the imported brands and Saratom the indigenous brand, all other brands had provision for observation.

In all electrical brands, the regulator was found to be a common feature which was easily accessible, easy to manipulate and read. The imported brands had special provision for broiling, this was absent in the case of the indigenous brands.

Insulating material was provided in all the imported brands. Racold was the only indigenous brand with insulation.

Vents were provided in all the electrical ovens, and located so as to prevent decolourization of walls.

The finish of the exterior, interior, base, shelves and baking pans were good.

Baking pans were of suitable sizes and arranged well without touching each other as well as the oven wall. Electrical details and instructions for use were given for all electrical ovens.

Regarding the evaluation of the non electrical ovens, the two brands namely peacock and guarantee used by the sample were considered easy to operate and clean but

required constant attention. The heat retention capacity was unsatisfactory . These brands had sufficient number of shelves which were neither stain, grease or rust proof.

b. Shopping survey:

Nine electrical brands namely Rashmi, Heatray, Amarjothi, Homa, E.M.T, Saratom, bajaj, Deluxe and Racold were available. Bajaj being most popular, second to which was Deluxe and Saratom. The remaining six brands were available only in a particular store. Six brands namely Bajaj, Racold, Homa, Heatray, Saratom, and Amarjothi operated automatically. Three different models of non electrical ovens were available in three shops. One out of which had a brand name (Peacock). The other two types did not possess any brand name.

The dimensions of the different ovens and their parts are presented in Appendix III. All the electrical brands available in the local markets had one shelf. The materials used for the different parts of the oven cost, special features, current and temperature^{aaa} the same, as discussed under the same heading for the household survey.

With regard to the non electrical ovens, all the brands were of the free standing type. The time taken for preheating ranged from 10 to 15 minutes. Charcoal was the fuel mainly used for the non electrical ovens. The ovens

irrespective of the brands and shops were sold on a ready cash basis. Majority of the shops sold only an oven per month and spare parts were not available in the shops.

B. Development of the design:

This phase of the study included the following aspects:

1. Development of design,
 2. Selection of materials,
 3. Determination of dimensions,
 4. Construction of oven.
- and 5. Cost of the oven.

1. Development of design:

The details obtained from both the household and shopping surveys served as a basis for the development of the design. An idea about the details of the oven - the metals to be used, the dimensions of the oven and design was obtained from the last phase of the study. Of the designs observed one non electrical brand (Guarantee) was procured specifically for the study. This was an oven without an insulation and made of tin.

2. Selection of materials:

Aluminium, of 24 gauge thickness was selected as the suitable metal for the inner case. This is durable, inexpensive, does not rust, and is a good conductor of heat-states Sater and Peet (1933) and Beveridge (1963). Zinc of 26 gauge

thickness was selected for the outer case of the oven. Ehrenkranz and Inman (1958) feel that zinc is a hard metal and it is grease and water proof. Asbestos, an insulating material was considered suitable to be provided in between the two walls of the oven. Johnston (1965) affirms that asbestos is light in weight, non-combustible and has high resisting qualities. A tight fitting door made of zinc with heat resistant glass at the centre was provided to help observe the products while in the process of baking. A heat resistant bakelite handle, four inches in length and half an inch in width was another feature of the oven designed. The oven liner was welded at the sides to prevent leakage of moisture into the insulation. To make the oven suitable for baking purposes, two shelves made of zinc and baking pans of aluminium were provided.

3. Determination of dimensions:

The household and shopping surveys helped in gaining an approximate idea of the dimensions of the oven to be constructed. The dimensions of the various parts of the newly designed oven are as given below.

TABLE IV
DIMENSIONS OF THE NEWLY DESIGNED OVEN.

S. No.	Particulars	Dimensions in cm							
		Case		Door	Shelf	Glass	Bak- ing Pan	Distance between shelves.	
Outer	Inner								
1.	Length	28	23	28	22	18	--	Top to I shelf	8
2.	Width	28	23	28	22	18	--	I to II shelf	8
3.	Height	28	23	28	--	--	5½		
4.	Diameter	--	--	--	--	--	20½	II shelf to Base	7

4. Construction of the oven:

The oven designed consisted of the following sections: The same is as presented in fig.I. An outer case (A) and an inner case (B), the two together formed a square box. The insulating material (C) was introduced between the two cases on the three sides of the oven except the top and bottom. The base was not fully covered but had a circular opening of 12 cm. diameter to enable heat transmission. This is presented in Fig.II. The shelves (D) slide well in a rigid, horizontal position within the supports and the shelf supports form an integral part of the side walls. Five apertures (G) were provided at the top of the box to allow the hot air out. The door (H) was provided with

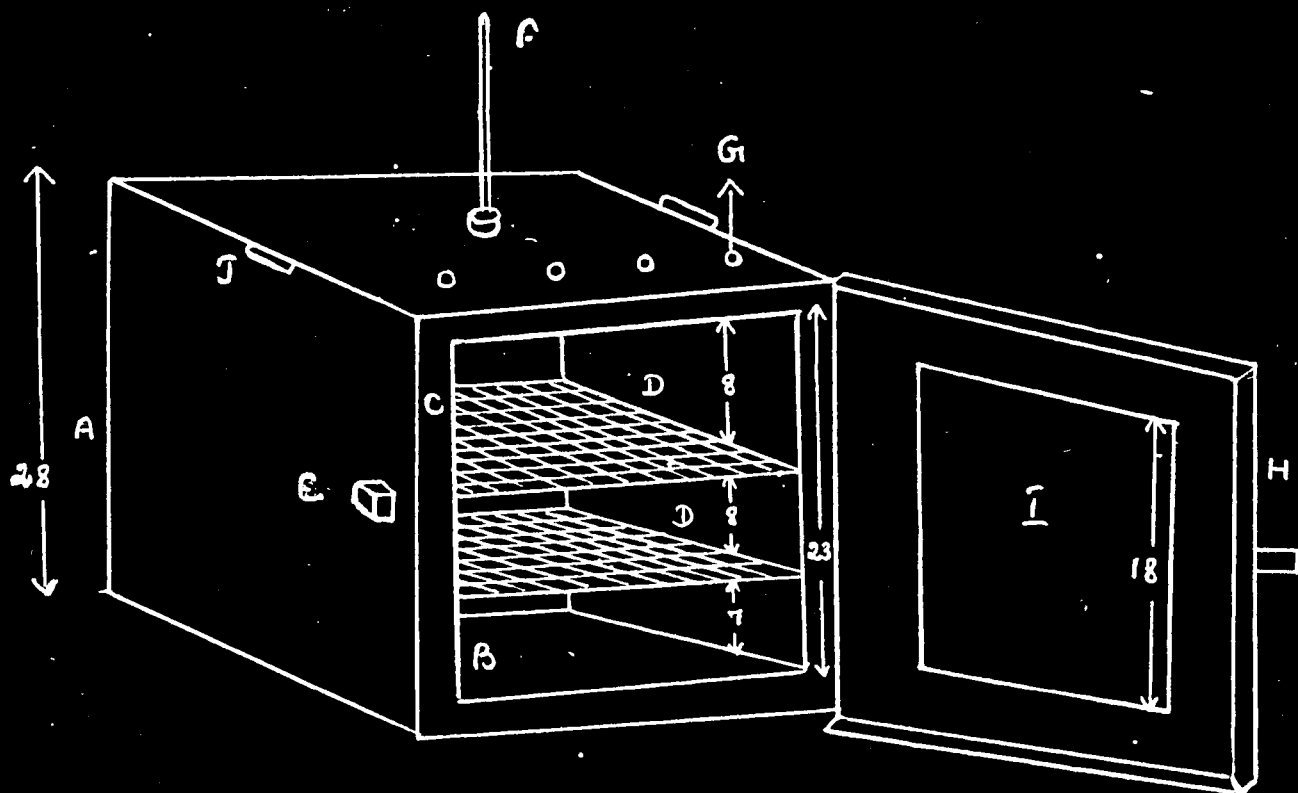


FIGURE - 1
BAKING OVEN [C]

NOTE :

A . OUTER CASE

B . INNER CASE

C . ASBESTOS

D . BAKING SHELVES

E . KNOB

F . THERMOMETER

G . AIR HOLES

H . DOOR

I . HEAT RESISTANT
GLASS

J . BAKELITE

HANDLES

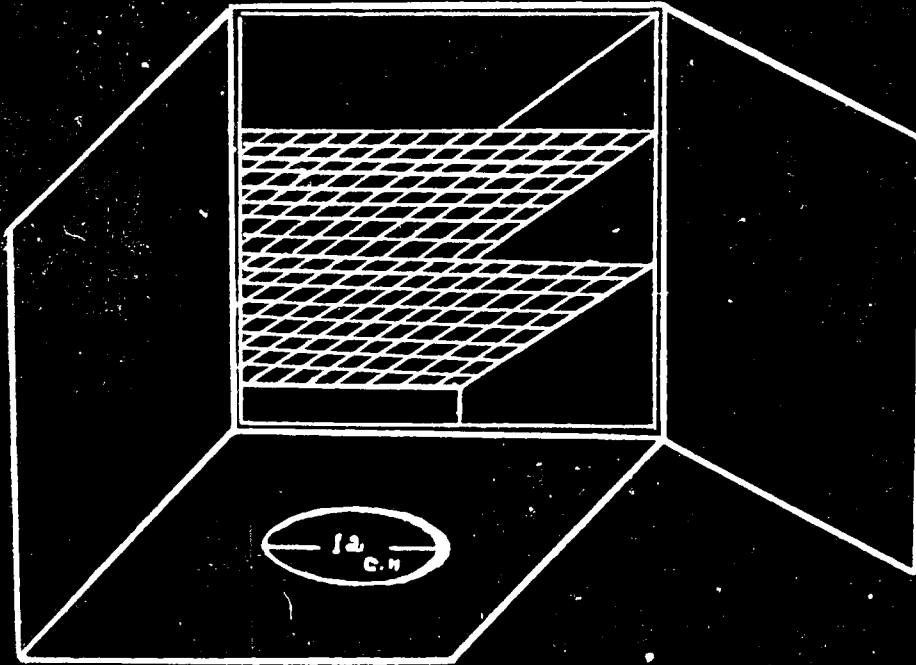


FIGURE - 2

THE BASE OF THE BAKING OVEN

a heat resistant glass (I) at the centre. Two bakelite handles (J) were provided on the sides of the oven. The door knob (E) was fixed on the left side of the oven. According to Pollard (1956) straight sides, flatbottoms, and a tight fitting lid or door are the essential features of a good oven. The oven designed confirms ideally to the above mentioned criteria. Fig. III represents the constructed oven.

5. Cost of the oven:

The cost incurred for the construction of the design is as given in Table below.

TABLE V
COST OF THE OVEN

Materials	Size	Cost	
		Rs.	P.
1. Aluminium and Zinc Sheet	10 sq.ft.	15	50
2. Bakelite handle	-	5	00
3. Heat resistant glass	18 x 18 'CM'	4	00
4. Asbestos	3 sq.ft	5	00
5. Door knob	-	0	50
6. Labour	-	12	00
Total		42	00

The weight of the oven thus made was 5½ kg. and the total cost was Rs. 42.00.

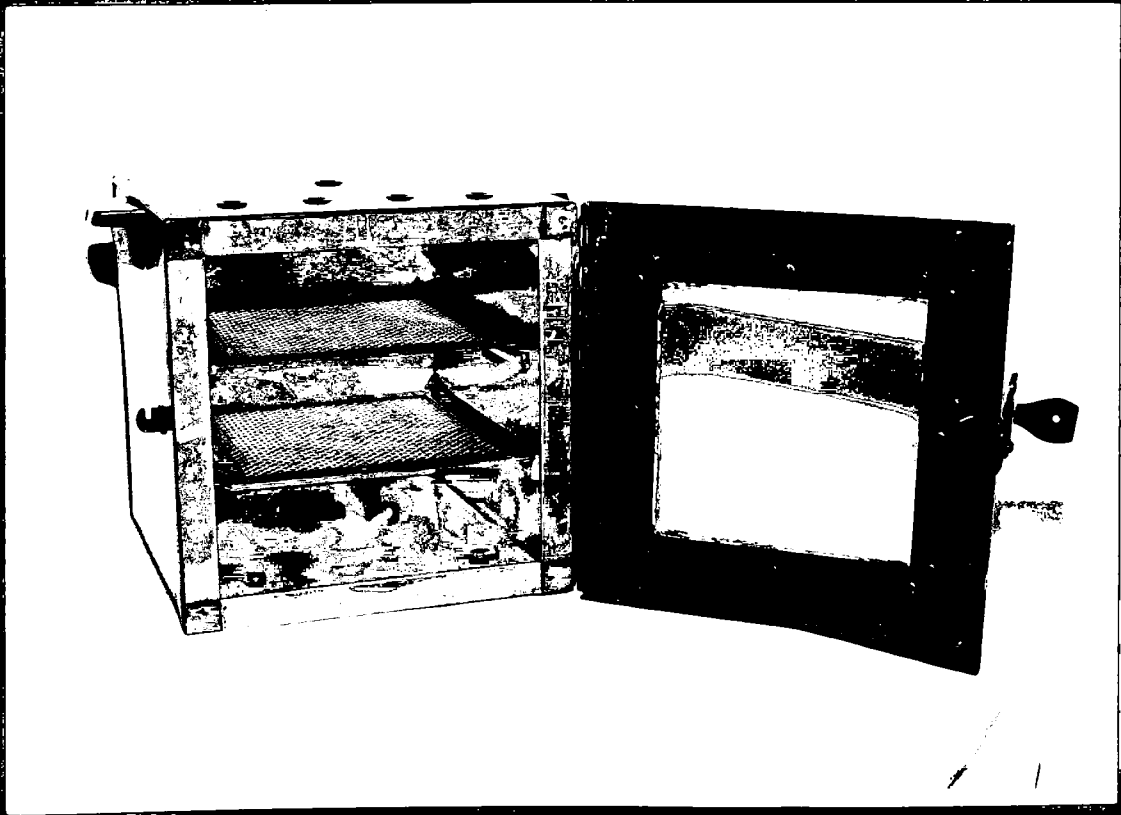


FIGURE - 3.

THE NEWLY CONSTRUCTED OVEN

D. Evaluation of the newly designed oven:

In order to judge the suitability of the newly designed oven with regard to time expenditure, cost of the fuel and palatability of the baked products, cooking experiments were conducted by the investigator which included the following steps:

1. Selection of ovens for comparison,
2. Selection of recipes to be prepared,
3. Standardisation of the cooking procedure,
4. Preparation of items,
5. Conducting acceptability tests,
- and 6. Evaluation of the oven by homemakers.

1. Selection of ovens for comparison:

Three ovens were selected for comparison. The same are as shown in Fig.IV.

(A) represents the non electrical oven without an insulation. (B) represents the medium size - Getco electrical oven. This was one among the common brands possessed by the sample. (C) represents the newly designed non electrical oven with an insulation.

2. Selection of recipes to be prepared:

Sponge cake and Biscuits were selected for the study, because a majority of the homemakers interviewed were familiar with the two products.

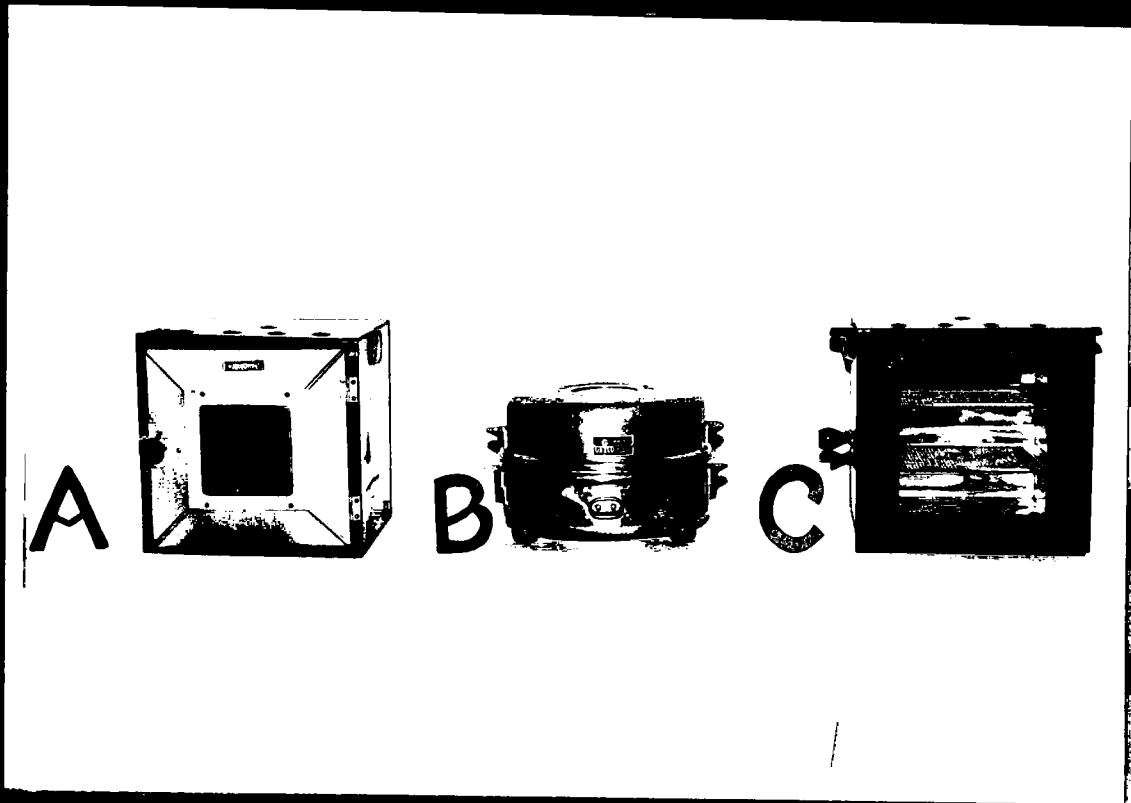


FIGURE - 4.

THE OVENS SELECTED FOR COMPARISON

* Recipe for cake:

Ingredients:

Flour : 105gm
 Butter : 125gm
 Sugar : 60gm
 Egg : 35gm
 Baking powder : a pinch

* Recipe for Biscuit:

Ingredients:

Flour : 105gm
 Sugar : 140gm
 Butter : 60gm
 Baking powder : a pinch

3. Standardisation of the cooking procedure:

The above mentioned standardised recipe was followed, the mixing of cake was done following the conventional method. This is usually conceded to be the best method which gives the best texture of cake states Hughes (1955). This consisted of creaming the fat and sugar, adding egg yolks to the fat sugar mixture and stirring well until the mixture was well blended.

The dry ingredients were sifted together and added. Beaten egg whites were quickly stirred in at the end to avoid loss of carbon-di-oxide gas.

In the preparation of biscuits dry ingredients were mixed. The butter was added to the mixture blended well, and kneaded lightly for 10 to 12 seconds. Then they were rolled and cut into squares and placed on an ungreased cookie sheet and baked. For both the items the mixture was prepared and divided equally for the three ovens.

* Robinson, C.H. "Normal and Therapeutic Nutrition" Calcutta, Oxford and IBH Publishing Co., 1967, p. 754.

4. Preparation of the items:

Two identical stoves of the "UMRAO" brand was selected. Each stove was filled with 500 millilitres of kerosene prior to starting the experiment. After each experiment was over the remaining kerosene was measured using a graduated cylinder.

In the case of the electric oven, the fuel consumption was calculated using the given formula:

$$\begin{aligned} * 1100 \text{ Watts} &= 1.1 \text{ kilo watts} \\ 1.1 \text{ K.w} \times \text{time taken} &= \text{k.w. hour} \\ \text{Cost of operation} &= \text{k.w. hour} \times \text{paise/unit} \end{aligned}$$

Using the above mentioned formula the cost of fuel was calculated. The experiments were conducted at a specified time each afternoon and the same was repeated thrice.

A record was made of the room temperature, the time taken for mixing and baking, temperature obtained, and weight of the products after baking at all times for the replicants.

5. Conducting acceptability tests:

In order ^{to} evaluate the palatability of the products baked in the three different ovens, palatability tests were conducted. This included,

- i. Development of score card,
- ii. Selection of taste panel,
- and iii. Administration of palatability tests.

* Peet, L.J. "Young Home Makers Equipment Guide" Ames, Iowa state University Press, 1967, P.277.

i. Development of score card:

To Nason (1939) a score card is helpful in rating the food subjectively. According to Griswold (1962) a score card usually includes a series of descriptive terms to guide the judge in grading each factor. A three point score card was developed for both the cake and biscuits. The same are presented in Appendix IV.

ii. Selection of taste panel:

Five Post-graduate students from Sri Avinashilingam Home Science College were selected to evaluate the newly designed oven. A triangle test was conducted to select the judges for the same. Amerine et al (1965) claim that this test is used as a method of selecting expert tasters. Lowe (1955) emphasizes that a triangle test is especially well adopted to selecting and training a panel and to controlling the quality of a product.

For the triangle test three samples were presented, two of which were identical. The judges were asked whether there was any difference among the samples and if so, to identify the duplicate sample. The food products were labeled with difference. (Vide Appendix V)

iii. Administration of palatability tests:

The palatability of the cakes and biscuits prepared out of the three selected devices were judged by the panel.

6. Evaluation of the oven by the home makers:

In order to evaluate the newly designed oven, three homemakers who had other brands of the non electrical ovens were selected. The evaluation was done using part B of the Interview schedule. (Vide Appendix I)

IV. RESULTS AND DISCUSSION

The findings of the study on "Designing and Evaluating a low cost non electrical baking oven" are presented under the following headings:

- A. Time taken for baking,
- B. Cost of fuel required for baking,
- C. Temperature range,
- D. Weight of the baked products,
- E. Palatability of products,
- and F. Evaluation of the new device by the selected homemakers.

A. Time taken for baking:

Time taken for baking cakes and biscuits in the three selected devices are presented in the following Tables:

TABLE VI

TIME TAKEN FOR BAKING CAKES IN THE THREE SELECTED DEVICES .

Device	Replicants (Time in minutes)			Mean	F. Value
	I	II	III		
A	0.40	0.43	0.43	0.42	63.00**
B	0.20	0.25	0.20	0.22	A VS C**
C	0.30	0.30	0.30	0.30	43.40

** Significant at one per cent level.

Shukla and Gulshan (1970) state that the analysis of variance is a method of splitting the total variation of the data into constituent parts which measure different sources of variation. On an average the time taken for baking a cake in the newly designed oven was comparatively less than that of the other non electrical oven. This may be attributed to the fact that the insulating material provided in the former reduced the time required by concentrating and preventing the transmission of heat from the inner case. On statistical analysis, it was revealed that within the models compared, a significance of the order of one per cent was denoted. Likewise a level of one per cent significance was found between the models A and C (Vide Appendix VI).

TABLE VII

TIME TAKEN FOR BAKING BISCUITS IN THE THREE SELECTED DEVICES

Device	Replicants (Time in minutes)			Mean	F. Value
	I	II	III		
A	0.30	0.30	0.30	0.30	56.6667**
B	0.15	0.15	0.15	0.15	A VS C
C	0.20	0.20	0.20	0.20	50.00**

** Significant at one per cent level.

In analogy to the other devices, device (c) took the least when compared to (A) and was second to (B). Between the models and within the non electrical devices the level of significance was again found to be of the order of one per cent (Vide Appendix VII).

B. Cost of fuel required for baking:

The total cost of fuel required for baking cakes and biscuits using the three selected devices are presented in the following Tables.

TABLE VIII

TOTAL COST OF FUEL REQUIRED FOR BAKING CAKES
IN THE THREE SELECTED DEVICES

Device	Replicants (Total Cost in Paise)			Mean	F. Value
	I	II	III		
A	12.5	12.8	12.8	12.7	1113.29**
B	2.8	3.2	2.5	2.7	A VS C
C	9.6	9.5	9.6	9.6	210.43**

** Significant at one per cent level.

The cost of fuel depends on the quantity of kerosene and electricity consumed which is directly proportional to the time taken. On a comparative basis the cost of operation was lower since the fuel required

For the newly designed oven (C) was lower than that of (A). For model (B) the cost was calculated using the formula mentioned in Chapter III. On an average the cost for baking a cake was around 12.7 paise for a period of forty two minutes in model (A) while it was 9.6 paise in model (C) for a period of thirty minutes.

The cost of kerosene per litre was 65 paise, while for electricity, the cost per unit was 11 for three phase current.

TABLE IX

TOTAL COST OF FUEL REQUIRED FOR BAKING BISCUITS IN THE THREE SELECTED DEVICES.

Device	Replicants (Total Cost in Paise)			Mean	F. Value
	I	II	III		
A	8.0	8.2	8.0	8.1	1065.67**
B	1.9	1.5	1.9	1.8	A VS C
C	6.2	6.5	6.5	6.4	139.00**

** Significant at one per cent level.

The cost of fuel required for baking biscuits in model (C) was relatively less when compared to model (A). The level of significance being one per cent between and within the non electrical models. (Vide Appendix IX).

C. Temperature range:

The temperature range obtained while baking cakes and biscuits in the three selected devices and the analysis of mean differences are given in the Tables: X and XI

TABLE X

TOTAL TEMPERATURE OBTAINED WHILE BAKING CAKES IN THE THREE SELECTED DEVICES.

Device	Replicants Temperature in C°			Mean	F. Value
	I	II	III		
A	118	120	120	119	54651.58**
B	400	400	400	400	A VS C
C	132	135	135	134	235.53**

** Significant at one per cent level.

The temperature obtained while baking a cake in the newly designed oven was comparatively greater than the temperature obtained in the case of model (A). There was a significant difference of one per cent between the models and within the non electrical models. (Vide Appendix X)

TABLE XI
TOTAL TEMPERATURE OBTAINED WHILE BAKING BISCUITS
IN THE THREE SELECTED DEVICES.

Device	Replicants Temperature in C°			Mean	F. Value
	I	II	III		
A	75	70	75	73	22476.33**
B	350	350	350	350	
C	90	88	90	89	119.25

** Significant at one per cent level.

As in the case of the former, the level of significance was of the order of one per cent between models (A) and (C). The temperature obtained in model (C) being relatively high (Vide Appendix XI).

TABLE XII
TEMPERATURE RANGE OBTAINED IN THE TWO MODELS FOR A PERIOD
OF FORTY MINUTES

Time taken in Minutes	Temperature obtained in C°	
	Model A	Model C
10	60	90
15	90	120
20	120	140
25	130	150
30	140	155
35	145	160
40	150	165

The increase of temperature in both the models was recorded every five minutes. The first reading was taken at the end of the tenth minute. At this point there was a difference of 30°C between model (A) and model (C), model (C) gained a greater, temperature. The temperature was recorded consecutively for forty minutes. At the end of this time also model (C) gained the maximum temperature. The same is given in Figure V.

D. Weight of the baked products:

Table XIII and XIV present the weight of the baked products obtained on using the three selected devices.

TABLE XIII

WEIGHT OF CAKES AFTER BAKING IN THE THREE SELECTED DEVICES

Device	Replicants (Weight in Grams)			Mean	F. Value
	I	II	III		
A	190	192	190	191	91.39 **
B	200	200	200	200	A VS C
C	200	198	200	199	126.60 **

** Significant at one per cent level.

The weight of cake prepared in the newly designed oven was greater than the weight of the product obtained from model (A). The mean difference was about



SCALE :

x axis : 2 cm : 5 mins

y axis : 1 cm : 20°C

KEY :

— MODEL C

— MODEL A

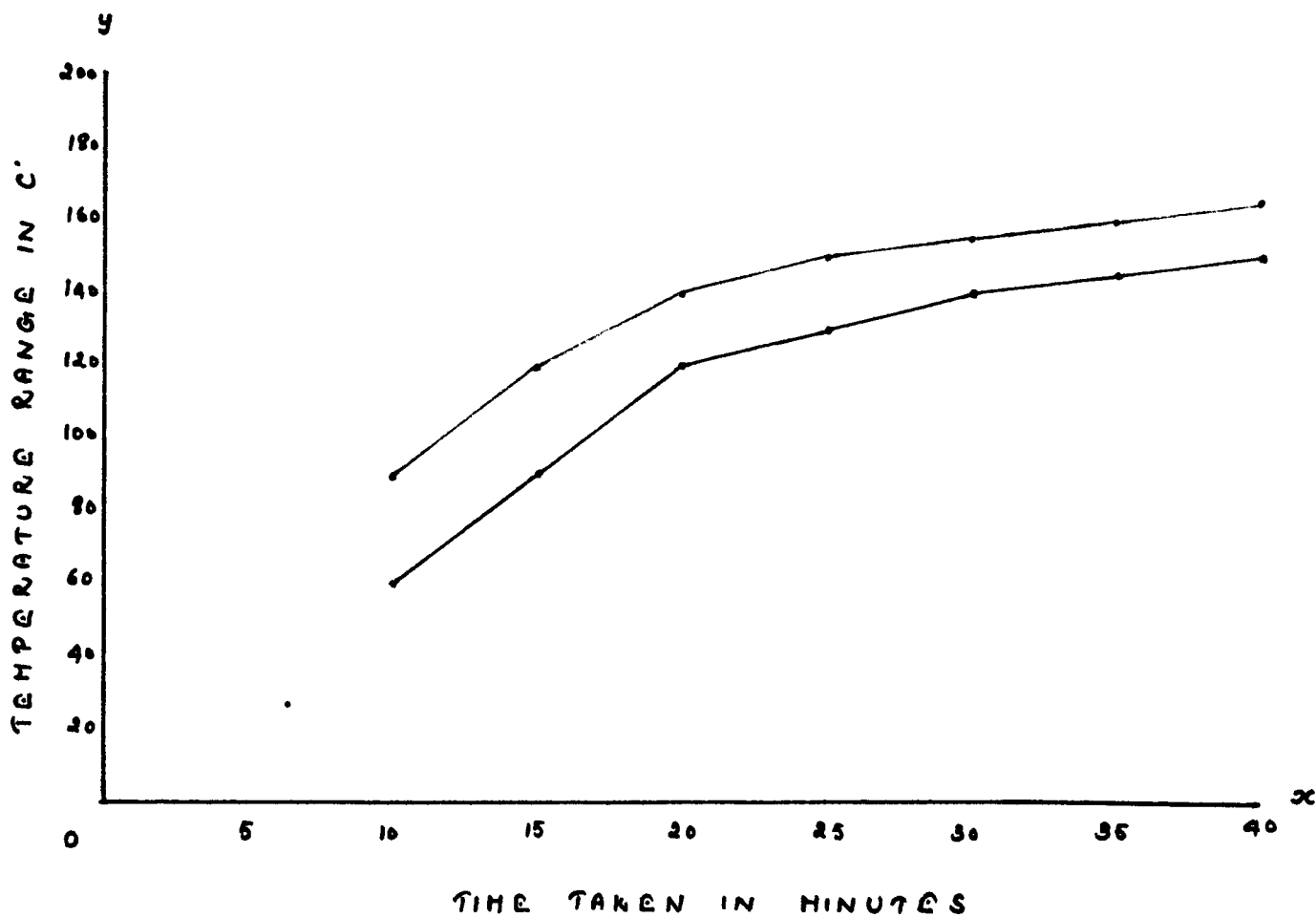


FIGURE : 5

TEMPERATURE OBTAINED IN THE TWO MODELS FOR A PERIOD OF FORTY MINUTES.

eight grams. This difference may be attributed to the reason expressed by Lowe (1955), according to whom cakes baked at lower temperatures shrink most both in height and from the sides of the pan. As the oven temperature is elevated the shrinking progressively decreases. This difference was evident in the products obtained from the two devices (Vide Appendix XIII).

The difference in temperature also affected the quality of the cake. The cake baked in model (A) had thicker cell walls, coarser and harsher texture. Lowe (1955) states that at the lowest temperature more than the optimum amount of gas escapes and more than the optimum agitation occurs within the batter before coagulation of the proteins start.

The weight of biscuits prepared in the three devices are as given in the Table below:

TABLE XIV
WEIGHT OF BISCUITS AFTER BAKING IN THE THREE SELECTED
DEVICES

Device	Replicants Weight in Grams			Mean	F. Value
	I	II	III		
A	142	140	142	141	78.40**
B	150	150	150	150	A VS C
C	150	148	150	149	107.87**

** Significant at one per cent level.

The weight of the biscuits obtained from the newly designed oven was greater than the products obtained from the other non electrical oven. There was a level of one per cent significance between and within the non electrical models. (Vide Appendix XIV).

C. Palatability of products:

The following Tables present the mean scores of palatability for the cake and biscuit samples obtained from the three selected devices.

TABLE XV
MEAN SCORES FOR PALATABILITY OF CAKES PREPARED
IN THE THREE SELECTED DEVICES

Qualities	Models			F. Value
	A	B	C	
1. Appearance	11	19	29	192.42** A VS C 23.09**
2. Texture	7	10	15	107.67** A VS C 213.33**
3. Doneness	10	10	15	18.47** A VS C 29.43**
4. Taste	8	10	15	33.45** A VS C 60.17**
5. Flavour	8	10	15	29.52** A VS C 44.28**
6. Colour	7	9	15	49.97** A VS C 93.85**
7. Shape	8	10	15	84.69** A VS C 163.33**

** Significant at one per cent level.

The over all differences in the palatability scores of the products obtained from the three models indicate a high level of significance. For each aspect

the level of significance was of the order of one per cent between the models and so also between model A and C (Vide Appendix XV). Thus the quality of the products obtained from (C) was comparatively good.

TABLE XVI

MEAN SCORES FOR PALATABILITY OF BISCUITS PREPARED IN THE THREE SELECTED DEVICES

Qualities	Models			F. Value		
	A	B	C			
1.Appearance	10	11	15	58.94**	A VS C	113.64**
2.Texture	8	11	15	30.43**	A VS C	60.06**
3.Doneness	9	12	15	105.83**	A VS C	209.43**
4.Taste	7	11	15	56.55**	A VS C	113.04**
5.Flavour	8	11	15	36.44**	A VS C	72.62**
6.Colour	9	11	14	19.00**	A VS C	37.50**
7.Shape	7	11	15	72.73**	A VS C	145.45**

** Significant at one per cent level.

The products prepared from the newly designed oven scored the highest with respect to all the qualities of palatability when compared to the other two devices. On statistical analysis it was revealed that within the models of A and C and between the three models a level of one per cent significance was noted. (Vide Appendix XVI).

F. Evaluation of the New device by the Selected
homemakers:

The results of the evaluation are as presented below:

As regards the general features of the oven, all the three homemakers considered this device to be better than the brands they possessed, as it was easy to operate, handle and clean. It was portable, had a neat and trim appearance and did not require constant attention. Good provision was made for the free circulation of heated air.

Considering the parts of the oven as the shelves, vent and door, the opinions of the judges were again in favour of the new device. They considered this device to be superior since it was the only model which had an insulation.

V. SUMMARY AND CONCLUSION

The study on "Designing and Evaluating a low cost non electrical baking oven" brought to light the following results.

1. Non electrical baking ovens were a rarity among ^{the} households surveyed.
2. The high and upper middle income groups alone possessed electrical ovens.
3. Both from the household and shopping survey it was evident that Bajaj was the most popular of all the electrical brands.
4. Two brands of non electrical ovens were available namely Peacock and Guarantee. The cost being Rs. 90 and Rs. 25 respectively.
5. The non electrical brand "Guarantee" when compared with the new device in terms of temperature range, time taken, fuel consumption and subsequent cost involved revealed that:

The temperature obtained while baking was comparatively greater in the case of the new device and there was a significant difference of one per cent between the models.

As regards the time taken, the new device was found to be more efficient than the other non electrical oven. There was a level of one per cent significance between the models.

On an average the cost of fuel required for baking in the newly designed oven was lower than that of the other non electrical oven. The difference between the models was again found to be significant at the one per cent level.

Taking into consideration the weight of the products, those obtained from the newly designed oven was greater than that of the other non electrical design and a significance of the order of one per cent was denoted between the models.

With regard to the palatability of the products, the newly designed oven scored the highest for all the aspects. Between the models the level of significance was of the order of one per cent for each and every aspect.

While evaluating the device the homemakers rated the new device as superior when compared to the other non electrical brand.

6. The cost of the newly designed oven was Rs. 42 with a break up of Rs. 30 for materials and Rs. 12 for labour, on the whole the device is well within the means of the middle income groups.

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A P P E N D I C E S

APPENDIX - I

INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING THE OVENS POSSESSED BY THE SELECTED HOUSEHOLDS IN COIMBATORE CITY

PART - A

I. Name of the investigator :

II. Name of the interviewee :

Serial No: _____

Date _____

Address - :

III. Type of family

: Nuclear

Joint

IV. Family background :

S.No. Relationship to the home maker Age Education Occupa-
-tion

Income per month (Rs.)

Career

Other sources

Total income:

V. General information of the oven:

S.NO.	Brand Name	No. possessed		Non electrical	Cost Rs.	Trade Mark No.	Guarantee Period	By	Plance of purchase	Year of purchase	Mode of purchase	
		Auto-matic	Non-auto matic								Cash	Instalment

VI. Particulars regarding the electrical oven:

a) Physical features:

S.No.	Brand Name	DIMENSIONS (CM.)						SHELF DIMENSIONS (CM)				MATERIALS USED								
		EXTERIOR			INTERIOR			Length	Width	Depth	Diameter	No. of shelves	Length	Width	Diameter	Distance between shelves	Body	Accessory	Door	Insulation
		Length	Width	Depth	Diameter	Length	Width													



b). Total loading and temperature:

S.No.	Brand Name	AC	DC	Watts	Volts.	Type of Switch		Preheating time	Temperature range
						Rotary	Push button		

C) Special features:

S.No.	Parts	Yes	No
1.	Drip pan	..	..
2.	Drip tray	..	..
3.	Oven gasket	..	..
4.	Signallight	..	..
5.	Oven baffle	..	..
6.	Thermostat	..	..
7.	Any other:	..	..

VII. Particulars regarding the non electrical oven:

a) Physical features:

S.No.	Type	Dimensions	SHELF DIMENSIONS
	Built-in Freestanding	EXTERIOR INTERIOR	USED
Brand Name		Length Width Depth	
		Diameter	
		Length Width Depth	
		Diameter	
		No. of shelves	
		Length Width Diameter	
		Distance between shelves	
		Body Accessory	

B) Fuel consumption:

S.No.	Type of fuel used	Preheating time
-------	-------------------	-----------------

VIII. Details regarding the use of oven:

S.No.	Products prepared	Time taken	Frequency of preparing	Satisfaction derived	Person using the oven			Problems faced
					Homemaker	Children	Any other	

IX. Care and maintenance of oven:

S.No.	Parts	Detergents used	Frequency of cleaning	Care taken while not in use	Repairs		
					Part repaired	Frequency	Cost incurred
1.	Exterior						
2.	Interior						
3.	Shelves						
4.	Oven pans						

X. Indicate from the points given below 5 important factors which you have taken into consideration prior to the purchase of the equipment:

1. Popularity of the brand
2. Availability
3. Guarantee given
4. Cost
5. Seal of approval
6. Special features
7. Durability
8. Convenience in use
9. Efficiency
10. Ease of operation
11. Silence in operation

XI. Evaluation of oven.

PART - B

S.No.	Particulars	Yes	No
A.	<u>General Features:</u>		
	1. Portable		
	2. Easy to operate		
	3. Easy to handle		
	4. Retains heat well		
	5. Does not require constant attention		
	6. Provision for free circulation of heated air		
	7. Neat and trim appearance		
	8. Easy to clean		
B.	<u>Shelves:</u>		
	1. Rust proof (Resistent)		
	2. Grease proof		
	3. Stain proof		
	4. Non-corrosive		
	5. Sufficient number of shelves		
	6. Baking area is sufficient		
	7. Removable shelves		
	8. Shelves have firm supports		
	9. Provision for locking device		
	10. Shelves are of sliding types		

S.No.	Particulars	Yes	No
-------	-------------	-----	----

B. Shelves:

- 11. Does not decolourise
- 12. With stands high temperatures
- 13. Has supports for placing shelves at different levels

C. Door:

- 1. Shuts tightly and slides smoothly
- 2. Moisture tight
- 3. Heat does not escape
- 4. Door is lagged
- 5. Handles easy to grasp
- 6. Provision for observation
- 7. Made of heat resistant material

* D. Regulator:

- 1. Easily accessible
- 2. Easy to manipulate
- 3. Easy to read
- 4. Has the following positions for - pre heating
 - Baking
 - Broiling

S.No.	Particulars	Yes	No
E.	<u>Insulation:</u>		
	1. The top, sides and door are well insulated		
F.	<u>Vent:</u>		
	* 1. It is accessible		
	2. Adjustable		
	o 3. Out let for smoke or odours		
	4. Located so as to prevent vapour decolourisation of walls		
*G.	<u>Thermostat:</u>		
	1. Has a separate dial		
	2. Not combined with the oven switch		
H.	<u>Finish:</u>		
	1. Has a good finish - Exterior Interior Base Shelves Baking pans		

S.No.	Particulars	Yes	No
I	<u>Baking pans:</u>		
	1. Suitable sizes		
	2. Arranges well in the oven		
	3. Does not touch each other		
	4. Does not touch the oven wall		
*J	<u>Safety factors:</u>		
	1. Has a separate fuse		
	2. Has a circuit fuse		
*K	<u>Information of the equipment:</u>		
	1. Electrical details		
	2. Instructions for use.		
*	Applicable to electrical ovens alone		
o	Applicable to non electrical ovens alone		

APPENDIX - II

INTERVIEW SCHEDULE TO ELICIT INFORMATION ON THE AVAILABILITY OF OVENS IN THE SHOPS OF COIMBATORE CITY

Serial No. :
Date:

I. Name of the investigator:

II. Name of the shop:

Address:

III. General information of the oven:

S.No.	Brand Name	Electrical	Non electrical	Size	Cost Rs.	Model No.	Trade Mark	Guarantee		Seal of appr- oval	Details on name plate	Manufact- urer's address
								Period	BY			
<hr/>												
<hr/>												

IV. Particulars regarding the electrical oven:

a) Physical features:

S.No.	Brand Name.	DIMENSIONS (CM)				No. of shelves	Shelf Dimensions (CM)			Distance between shelves	Materials used						
		Exterior		Interior			Length	Width	Depth		Insulation	Door	Accessory	Body			
		Length	Width	Depth	Diameter		Length	Width	Diameter								



b) Total loading and temperature:

S.No.	Brand Name	AC	DC	Watts	Volts	No. of switch positions	Type of switch	Pre heating time	Temperature range
							Rotary	Push button	

C) Special features:

S.No.	Parts	Yes	No
1.	Drip pan	..	..
2.	Drip tray	..	..
3.	Oven gasket	..	..
4.	Oven baffle	..	..
5.	Signal light	..	..
6.	Thermostat	..	..
7.	Any other	..	..

V. Particulars regarding the non electrical oven:

a) Physical features:

S.No.	Brand Name	DIMENSIONS (C.M.)		No. of shelves	Materials Used
		EXTERIOR	INTERIOR		
		Length	Depth	Di meter	Distance between shelves Body Accessory
		Width	Depth	Di meter	
		Length	Width	Di meter	
		Width	Length	Di meter	

B) Fuel consumption:

S.No.	TYPE	Type of fuel used	Pre heating time
	Built-in	Free-Standing	

VI. Furnish the following details:

- a. Brand which is in demand :
- b. Number sold per month :
- c. Spare parts available :
- d. Mode of Sales : Cash Instalment

APPENDIX. III

DIMENSIONS OF THE OVENS AVAILABLE IN SHOPS.

Brand Name	Size	DIMENSIONS IN C.M.										
		Exterior				Interior				Shelf		
		L	W	H	D	L	W	H	D	L	W	D
<u>ELECTRICAL</u>												
Bajaj	Small	-	-	20	25	-	-	20	25	-	-	24
Bajaj	Medium	-	-	25	35	-	-	25	35	-	-	34
Deluxe	Small	-	-	20	25	-	-	20	25	-	-	24
Deluxe	Medium	-	-	25	35	-	-	25	35	-	-	34
Amarjothi	Medium	-	-	25	35	-	-	25	35	-	-	34
Amarjothi	Big	-	-	30	45	-	-	30	45	-	-	44
Saratam	Standard	45	37	33	-	28	28	23	-	28	25	-
Rashmi	Medium	-	-	25	35	-	-	25	35	-	-	34
Heat ray	Big	-	-	30	45	-	-	30	45	-	-	44
Racold	Standard	30	55	32	-	23	45	28	-	23	35	-
Homa	Medium	-	-	25	35	-	-	25	35	-	-	34
E.M. T.	Standard	40	35	32	-	25	23	20	-	22	20	-
<u>NON ELECTRICAL</u>												
Peacock	Big	60	30	20	-	58	28	20	-	55	25	-
Peacock	small	30	30	20	-	26	25	20	-	25	25	-
-	Small	14	14	14	-	12	12	12	-	12	12	-
-	Big	30	30	20	-	25	25	15	-	20	10	-

NOTE:

L = Length

W = Width

H = Height

D = Diameter

APPENDIX. IV

SCORE CARD TO EVALUATE THE CAKE PREPARED IN THE THREE SELECTED DEVICES.

ASPECTS	Marks Given		
	Model A	Model B	Model C
A. EXTERNAL APPEARANCE;			
1. Even and uniform			
2. Free from cracks			
3. Burst on top			
B. INTERNAL APPEARANCE;			
1. Fine and even grain			
2. Coarse grain			
3. Irregular grain			
C. TEXTURE			
1. Soft			
2. Crisp			
3. Sticky			
D. DONENESS;			
1. Well baked			
2. Ordinarily baked			
3. Over baked			
E. TASTE;			
1. Good			
2. Fair			
3. Poor			
F. FLAVOUR;			
1. Pleasant			
2. Acceptable			
3. Foreign			
G. SHAPE;			
1. Symmetrical			
2. Peaked			
3. Concave			
H. COLOUR;			
1. Golden Brown			
2. Brown			
3. Dark brown			
TOTAL SCORES			

APPENDIX. V

SCORE CARD TO EVALUATE BISCUITS PREPARED IN THE
THREE SELECTED DEVICES.

ASPECTS	MARKS GIVEN		
	MODEL A	MODEL B	MODEL C
A. EXTERNAL APPEARANCE			
1. Even and uniform			
2. Free from cracks			
3. Burst on top			
B. DONENESS:			
1. Well baked			
2. Ordinarily baked			
3. Over baked			
C. TEXTURE:			
1. Soft			
2. Tender			
3. Crisp			
D. FLAVOUR :			
1. Pleasant			
2. Acceptable			
3. Foreign			
E. TASTE:			
1. Good			
2. Fair			
3. Poor			
F. COLOUR:			
1. Golden Brown			
2. Brown			
3. Dark Brown			
TOTAL SCORES			

APPENDIX VI

CONDUCTION OF THE TRIANGLE TEST

No. of Students	Replicants		
	I time	II time	III time
1	✓	✓	✓
2	✓	✓	
3	✓	✓	✓
4	✓	✓	
5	✓	✓	
6	✓	✓	✓
7	✓	✓	
8	✓	✓	
9	✓	✓	✓
10	✓	✓	✓

APPENDIX - VII

ANALYSIS OF VARIANCE FOR THE TIME TAKEN WHILE BAKING
A CAKE IN THE THREE SELECTED DEVICES (MINS)

DEVICE	I	II	III	
A	0.40	0.43	0.43	1.26
B	0.20	0.25	0.20	0.65
C	0.30	0.30	0.30	0.90
	0.90	0.98	0.93	2.81

$$\text{Correction factor} = \frac{(2.81)^2}{9} = \frac{7.8961}{9} = 0.877$$

$$\text{Sum of squares between models} = \left| \frac{(0.9)^2}{3} + \frac{(1.26)^2}{3} + \frac{(0.65)^2}{3} \right| - \text{C.F.}$$

$$\begin{aligned} &= 0.940 - 0.877 \\ &= 0.063 \\ \text{Total sum of squares} &= \frac{(0.40)^2}{3} + (0.43)^2 + (0.43)^2 + (0.20)^2 \\ &\quad + (0.25)^2 + (0.20)^2 + (0.30)^2 + (0.30)^2 \\ &\quad + \frac{(0.30)^2}{3} - \text{C.F.} \\ &= 0.943 - 0.877 \\ &= 0.066 \end{aligned}$$

Source	Degrees of Freedom	Sum of squares	Mean	F. Ratio
Between Models	3-1 = 2	.063	0.0315	63.00
Within Models	8-2 = 6	.003	0.0005	Significant at 1% level
Total	9-1 = 8	.066		43.40
A VS C	1	.0217		Significant at 1% level

APPENDIX - VIII

ANALYSIS OF VARIANCE FOR TIME TAKEN WHILE BAKING
BISCUITS IN THE THREE SELECTED DEVICES

Sources	Degrees of freedom	Sum of squares	Mean	F. Ratio
Between models	3 - 1 = 2	0.034	0.017	56.6667
Within models	8 - 2 = 6	0.002	0.0003	Significant at 1% level
Total	9 - 1 = 8	0.036		
A VS C	1	0.015	0.015	50.00 Significant at 1% level

APPENDIX - IX

ANALYSIS OF VARIANCE FOR FUEL CONSUMPTION IN PAISE WHILE
BAKING CAKE IN THE THREE SELECTED DEVICES

Sources	Degrees of freedom	Sum of squares	Mean	F. Ratio
Between models	3 - 1 = 2	155.85	77.93	1113.29 Significant at 1% level
Within models	8 - 2 = 6	0.39	0.07	
Total	9 - 1 = 8	156.24	19.53	
A VS C	1	14.73	14.73	210.43 Significant at 1% level

APPENDIX - X

ANALYSIS OF VARIANCE FOR FUEL CONSUMPTION IN PAISE
WHILE BAKING BISCUITS IN THE THREE SELECTED DEVICES

Sources	Degrees of freedom	Sum of squares	Mean	F. Ratio
Between models	3 - 1 = 2	63.93	31.97	1065.67
Within models	8 - 1 = 6	0.20	0.03	Significant at 1% level
Total	9 - 1 = 8	64.13	8.01	
A VS C	1	4.17	4.17	139.00 Significant at 1% level

APPENDIX - XI

ANALYSIS OF VARIANCE FOR TOTAL TEMPERATURE OBTAINED
WHILE BAKING CAKE IN THE THREE SELECTED DEVICES (In.C)

Sources	Degrees of freedom	Sum of squares	Mean	F. Ratio
Between models	3 - 1 = 2	149745.33	74872.67	54651.58 Significant at 1% level
Within models	8 - 2 = 6	8.23	1.37	
Total	9 - 1 = 8	149753.56	.	235.53
A VS C	1	322.67	322.67	Significant at 1% level

APPENDIX XII

ANALYSIS OF VARIANCE FOR TOTAL TEMPERATURE OBTAINED
WHILE BAKING BISCUITS IN THE THREE SELECTED DEVICES
(In C°)

Sources	Degrees of Freedom	Sum of squares	Mean	F. Ratio
Between Models	3 - 1 = 2	144747.56	72373.78	22476.33
Within Models	8 - 2 = 6	19.33	3.22	Significant at 1% level
Total	9 - 1 = 8	144766.89		
A Vs C	1	384.00	384.00	119.25 Significant at 1% level

APPENDIX XIII

ANALYSIS OF VARIANCE FOR WEIGHT OF CAKE IN GRAMS AFTER
BAKING IN THE THREE SELECTED DEVICES

Sources	Degrees of Freedom	Sum of squares	Mean	F. Ratio
Between Models	3 - 1 = 2	162.67	81.34	91.39
Within models	8 - 2 = 6	5.33	0.89	Significant at 1% level
Total	9 - 1 = 8	168.00		
A Vs C	1	112.67	112.67	126.60 Significant at 1% level

APPENDIX XIV

ANALYSIS OF VARIANCE FOR WEIGHT OF BISCUITS IN GRAMS
AFTER BAKING IN THE THREE SELECTED DEVICES.

Sources	Degrees of Freedom	Sum of squares	Mean	F. Ratio
Between models	$3 - 1 = 2$	139.56	69.78	78.40
Within models	$8 - 2 = 6$	5.33	0.89	Significant at 1% level
Total	$9 - 1 = 8$	144.89		
A Vs C	1	96.00	96.00	107.87 Significant at 1% level