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I. INTRODUCTION

Women in India today, besides homemaking, have to fulfil many obligations, both in rural and urban areas. Devadas (1968)[1] states that farm and home are two integral parts of rural homemaker's life. She also points out that many women take to careers outside the home due to economic necessity or on account of the leisure which science has made possible (1969)[2]. Several of them shoulder responsibilities in the Panchayat Raj-village self government. This, while broadening their scope of service outside the home, has also increased their strain due to the dual role they have to play. In order to help them meet the demands of homemaking and outside responsibilities satisfactorily, methods and devices which will help them simplify labour in the home and wise management of the three resources namely time, energy and money are urgently needed. Gross and Lewis (1968)[3] define that "wise management is equivalent to striking a balance between saving of money through conservation of the materials and the saving of time and energy."

A major part of the homemaker's time is spent in the kitchen. Cooking for and feeding the family is one of the important duties of the homemaker. According to Ministry of Food and Agriculture (New Delhi)[4], "the most

important area of activity in the home is the kitchen where the housewife spends 70 per cent of her working time." Therefore any attempt to help the homemaker save time and energy must start with improvement in the kitchen structurally and in the procedures used.

Research is constantly being conducted in finding out more and more improved methods of cooking so that time, labour and money thus saved can be utilised for educational, spiritual and cultural pursuits. The modern society has provided many types of equipment for saving time and energy and thereby simplifying the homemaker's task. According to Khatu (1968)[5] use of labour saving kitchen equipment such as pressure cookers, refrigerators, mixers, blenders, grinders and others have contributed towards achieving comfort and convenience of the homemaker. Thabet (1967)[6] refers to a labour saving device as the "small appliance or the kitchen tool or something in that group of what we call the housewares that helps us get the job done with the least amount of effort and in the best possible way." Making available such labour saving devices suited to the customs, economic conditions and educational levels of Indian homemaker is a great task and no attempt has been made in this direction although much technological progress in basic and applied sciences

has been recorded in the recent years.

A family housing survey conducted by the investigator in the nearby village, 'Idayarpalayam', Coimbatore District, showed that most of the homemakers are ignorant of the common and easily available and less expensive labour saving devices. Therefore it is necessary that the villagers are made familiar of such less expensive labour saving equipment which are practicable to their way of living.

This study was therefore undertaken to compare advantages of one type of labour saving device namely the steam cookers. In order to determine which types of steam cookers will be most suitable or effective, three different types of cookers namely 'idli' steamer, a common type of steam cooker and pressure cooker, available in the market and one improvised by the investigator have been compared in the study by cooking a standardised breakfast, all other conditions remaining identical. The points of comparison were time, cost of equipment, cost of operation and palatability of the foods prepared.

II. REVIEW OF LITERATURE

Since the study is concerned with four different types of steam cookers, the following topics have been reviewed:

A. Methods of Survey.

B. Steam as a Medium of Cooking.

1. History of steam
2. Physics of steam.

C. Steaming as a method of cooking.

D. Studies conducted with steam and pressure cookers, and

E. Palatability tests.

A. Methods of Survey:

Among the various survey methods, questionnaire, observation, case study and interview are popularly used.

1. The questionnaire:

According to Goode and Hatt (1952)[7] questionnaire is a device to secure information by using a set of questions which will be filled by the respondent himself. Young (1956)[8] is of opinion that the questionnaire is designed to collect data from large, verse and widely scattered groups of people. It is useful in gathering objective, quantitative data as well as in securing of information of qualitative natures.

Observation:

Goode and Hatt (1952)[7] point out that observation consists of the simple method of looking

and listening as one of the most primitive and modern techniques. There are two types of observations controlled or uncontrolled and participant and non-participant. In controlled observation, the observer will become a temporary insider, and share the feelings of the groups of individuals observed. The purpose of observation is to perceive the nature and extent of significant inter-related elements within complex social phenomenon, culture patterns or human conduct.

Case Study:

Young (1955)[8] states that case study is a method of exploring and analysing the life of social unit - be that unit a person, a family, institution, culture, group or even a community. The aim of case study is to determine the factors that account for the complex behaviour patterns of the unit, and the relationships of the unit to its surrounding.

Interview method:

According to George (1963)[9] interview is a process of giving and taking between the interviewer and the interviewee. Interview helps to arrive at some judgement of truth of the answers that the respondent gives. Sheatsley (1967)[10] states that in interview, the investigator gathers data directly through face to face contacts, in contrast to the data gathering procedure, involved in the questionnaire. Young (1956)[8] points out that the interview may be regarded as a systematic

method by which a person enters more or less imaginatively into the inner life of a comparative stranger.

Advantages of 'Interview' method:

Good and Scates (1954)[11] regard that the interview enables the investigator to follow leads and to take advantage of small clues from the person interviewed. Further, the interview permits the investigator to form an impression of the person who is giving the information, to arrive at some judgement of the truth of the answers and to "read between the lines" things that may not have been said in words. It provides an opportunity for the interviewer to give information, and to develop certain attitudes on the part of the respondent, and it also permits an exchange of ideas and information. Moreover, the interviewee may provide personal and confidential information which he would not ordinarily give in writing. The interview is of special advantage wherein the interviewees are illiterate. Young (1956)[8] considers that the interview allows the interviewer to go behind more outward behaviours and aids in checking his external observations, and enables him to study motivations, emotional responses, and social processes, as they are reflected in human experiences and social situations.

B. Steam as a Medium of Cooking:

Since this study pertains to steam cooking, history

and physics of steam are reviewed.

1. History of steam:

Slabaugh and Butler (1965)[12] define "steam is a transparent, colourless white cloud or mist of lime water droplets." The Encyclopaedia Britanica[13] defines steam as "the vapour of water." In the pure state it is dry invisible gas. Often it is mixed with minute particles of water which are produced by condensation of portions of vapour. In such a mixture the suspended particles of water constitute a visible cloud. Any mixture of steam with water is known as wet steam which is generally present in a turbine.

According to Slabaugh and Butler (1965)[12] James Watt was the first scientist to demonstrate the use of heat energy in the form of steam to move an engine in 1769. Wilson (Wisconsin)[14] points out that 19th Century is often referred to as the steam age. Early in this period, the steam locomotive was invented and Fulton tried out his steam boat "Clermont." However, like many other wonders of modern times, the history of steam goes back to an even earlier period.

Anthropologists believe that shortly after the discovery of fire, pre-historic man must have dropped hot pebbles into water and discovered steam, although he did not know how to make use of the steam. In later ages pagan priests applied the mysterious power of steam to lift huge slabs of stone in order to keep their subjects spell bound. As early as 120 B.C., a writer

of Alexandria described the use of steam in rotating a toy.

In the later 17th and early 18th centuries, a young well educated French physicist by the name of Denis Papin began experimenting with steam, and brought to completion several important inventions, which included the first steam engine with a piston and a boat propelled by means of steam power, transmitted from a pumping engine. This was followed with the discovery of a most interesting and surprising cooking device utilising liquids under pressure. He called this contrivance "New Digester or Engine for softening bones." Allen and Maxwell (1952)[16] describe this as an engine which consists of a strong bronze vessel, with a tight fitting lid, and a safety valve to guard against excessive rise in temperature by allowing part of the steam to escape. This however did not receive popular support. Papin was forgotten for a long time. Since then, hundreds of years of research and experimentation have helped to bring the pressure cooker to its present adoptability.

The 20th century is known as the Electrical Age. However steam has not been displaced by electricity, since about 70 per cent of all electricity is generated by steam engines and turbines.

2. Physics of steam:

Whiteley (1952)[16] states that a substance may exist in three forms--solid, liquid or gas. Thus water can exist as the solid-ice, liquid-water

or gas-steam. It can be changed from the solid to gaseous state by raising its temperature." According to Trivedi and Shah (1951)[17] when a liquid is heated, its volume increases, and at a particular temperature the liquid begins to boil and gradually changes into vapour. The bubbles of vapour are formed within the liquid and rise to the surface, producing the effect of boiling. Whiteman (1951)[18] states that these bubbles are steam, which is water, in the form of a gas. When the whole liquid is converted into the vapour, the increase in the volume is much larger than when it is in the liquid state due to the molecular separation. Harrington (1957)[19] states that the molecules of the liquid are separated during the change of state from liquid to vapour. Heat is required to increase the inter molecular space. Hence this heat supplied cannot bring about any rise in temperature and is utilised for change of state and known as the latent heat of vaporization.

Dicer and High (1936)[20] define the Latent Heat of Vapourisation of water as "the quantity of heat absorbed in transforming one gram of water at its boiling point, into one gram steam at the same temperature." Black and Little (1956)[21] define the boiling point of a liquid as "the temperature at which its vapour pressure is one atmosphere, 76 cm. of mercury."

Nixon (1958)[23] states "the quantity of heat energy required to convert unit mass of a liquid into vapour at the same temperature is called the "Latent Heat of Vapourisation" of the substances. Units such as calories*/gram, British Thermal Unit**/pound are used for expressing latent heat. The latent heat of vapourisation of a substance is L Calorie per gram. Therefore it follows that mL calorie are required to vapourise m gram of a substance. Similarly, if m gram of the vapour condenses, mL calories of heat are given up. The heat is "latent" or hidden in the vapour. The value of latent heat of vapourisation for a given substance depends upon the temperature at which the change of state occurs.

The heat given to a gram of water at its boiling point to convert it into steam is utilised in (1) increasing the internal energy of water and (2) in doing work against the external pressure. The quantity of heat utilised in increasing the internal energy of water is called the internal latent heat, and the quantity of heat required by one gram of steam to do work against the external pressure during its expansion is called the external latent heat. In general, a change of volume occurs when a substance changes its state. Thus, at the

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* A calorie is the quantity of heat required to raise the temperature of 1 gram of water through $1^{o}C$.

** British Thermal Unit is the quantity of heat required to raise the temperature of 1 pound of water through $1^{o}F$.

atmospheric pressure, one cc of water at 100°C is converted into 1,674 cc of saturated steam at the same temperature. Through this expansion, external work is accomplished.

Superheated steam:

The temperature of saturated steam, at any pressure may be increased by the application of additional heat. Severns et al.(1954)[23] state that steam is superheated when the steam temperature is above the saturation temperature, corresponding to the steam pressure. The superheated steam is useful in increasing the temperature ranges of certain steam using equipment. The boiling point depends upon pressure. Slabaugh and Butler (1954)[12] state "as the pressure increases, the temperature of the boiling water increases." It is this principle which is used in the working of pressure cooker.

C. Steaming as a Method of Cooking:

Among the different methods of cooking food such as boiling, baking, steaming, frying and grilling or broiling; steaming is reviewed in the following pages from the available literature. Cooper et al.(1950)[24] and Holt (1954)[25] state that steaming is a method of cooking food in steam, produced from fast boiling water. Hamelton and Dow (1947)[26] are of opinion that steaming is applying heat to food through the medium of steam, and is done by placing the food on a perforated rack over boiling water. Steam may be

applied directly to the food as in a steamer or indirectly through a utensil as in the case of a double boiler (1968)[27].

According to Mank et.al.(1960)[28] the steam cooker is a "self contained, high speed, low temperature, moist heat, non-scorching cooking machine." The steam cooker is an efficient device for cooking. It helps to make cooking simple and convenient. In most types of steam cookers water is in the bottom compartment, which is in contact with the stove. The steam rises and passes through the several compartments containing different foods. Mait (1954)[26] stresses that the water beneath the steamer must be constantly boiling as otherwise the volume of steam will be insufficient. As the water evaporates, it should be replenished with boiling water. The cooker is tightly covered so that very little steam escapes and water in the steamer should be sufficient to surround the pan kept inside upto half its height. After the cooker and contents are heated to the temperature of steam, very little fuel is further required to complete the cooking process.

PRESSURE COOKERS

Pressure cooking is, cooking in steam under pressure as medium. Beveridge (1950)[29] reasons that the name 'pressure cooker' is due to the fact that it holds steam inside so that pressure is built up. As a result, higher temperatures are obtained than in an ordinary pan, and cooking time is shortened.

The 'Report on Steam Pressure Cookers' (1958)[30] states that cooking of foods in the pressure cooker starts as soon as the hot steam is admitted to the cooking compartment. The pressure cooker delivers a constant amount of heat to the food without circulation of air or temperature change.

West and Wood (1959)[31] state that modern steam cookers have controlling device which maintains constant temperature at any desired stage between 180° to 240° F. The temperature depends on the pressure reached and the altitude at which cooking is done. The controlling device therefore regulates the pressure in order to reach the desired temperature. In certain types of pressure cookers the temperatures reach only upto 230°F. Such pressure cookers are known as 'low pressure steam cookers.' The pressure used in this type of steam cooker, is usually three to ten pounds per square inch, going upto a maximum of four to sixteen pounds.

According to Ehrenkrans and Inman (1958)[32] different amounts of pressure such as five, ten and fifteen pounds can be obtained and regulated. At fifteen pounds, the boiling temperature is about 250° F, at ten pounds about 240°F, and at five pounds, about 228°F. At high altitudes due to the reduced atmospheric pressure, these temperatures are much lower for the same pressure applied.

The working of the Pressure Cooker: The working of the pressure cooker involves the following steps:

Adjustment of heat. As soon as boiling point is reached inside the cooker, steam is produced displacing the air inside. The vent weight prevents the escape of steam. As more steam is produced, it gets compressed, thus building up the pressure inside. This pressure holds the cover tightly against the cooker ensuring an air tight seal. When the inside pressure equals the weight of the vent weight as indicated in the gauge, the excess steam tries to escape, by pushing the weight. This causes 'jiggling' accompanied by a hissing sound. This sound indicates that the required pressure has been developed inside. At this stage heat should be reduced until only a gentle sound of steam escapes. 'Letting off' steam in spouts or continued loud hissing noise indicates defective handling of the cooker.

Adjustment of time: Vegetables and meats vary in their tenderness, according to the sizes into which they are cut. The time required for cooking them also vary correspondingly. All pressure cookers are provided with literature regarding the time required for cooking various foods. This time is generally on the basis that pressure cookers are cooled quickly after cooking. If, however, the pressure is allowed to drop normally until the pressure inside the cooker becomes normal, the total cooking time should be shortened accordingly. Salt (1954)[23], Halliday and Noble (1959)[24] suggest that when cooking in pressure cooker is completed, the pressure inside must

be reduced before the lid is removed. The pressure cooker can be cooled by either holding it under the cold water tap, letting the water flow over the bottom and sides or by standing in a basin of cold water for a few seconds or by letting it remain outside for sometime.

The advantages of steam cooking: According to Cummings (1938)[34] Stanley and Chime (1950)[35] and Ranganayaki (1962)[36], the advantages of steam cooking are; the food does not lose its soluble constituents and the vegetables retain their original shape and colour. Several dishes may be cooked in the same cooker simultaneously utilising the same fuel, thereby saving cooking space and fuel. Sweet puddings cooked by this method are light when compared to those cooked by boiling. Mack et al.(1960)[28] and Holman (1959)[37] point out another advantage that large and small quantities of food can be cooked with minimum amount of labour. Steaming baskets or containers do not necessitate securing as foods do not get burnt since direct contact with heat is eliminated. Further, keeping watch against boiling over, scorching or burning dry is not needed. Cooper et.al. (1950)[24] state that steaming is an economical method as very little heat is required to keep the water boiling and all the nutrients are retained. According to Holman (1959)[37] high speed cooking permits the preparation of small quantities of fresh food frequently, reducing waste and left-overs.

Pressure cooking has the following additional advantages

besides those mentioned in steam cooking. According to Denton (1921)[28] steam pressure cooker is suitable for home canning, tough meats, cereal preparations other than batters and doughs and dried legumes. The pressure cooker can be used for the extraction of maximum juice in the making of jelly. Grimsey, as quoted by Denton (1921)[28] showed that fruits cooked by steam pressure made 15 to 20 per cent more jelly than those cooked in a kettle or a double boiler. Macleod and Nason (1937)[29] and Stanley and Cline (1950)[25] point out that cooking in a pressure cooker gives products of good texture and flavour. Beveridge (1950)[29] remarks that maximum time is saved when the pressure cooker is used for foods that ordinarily require long time for cooking such as dry legumes, and tough meats. At high altitudes at which foods cook more slowly, because of the lower boiling point of water, the pressure cooker is a special boon. According to the Report on Steam Pressure Cookers (1948)[30] pressure cookers are used for pre-cooking, scalding, cooking and also reheating. However, Holt (1954)[25] remarks that pressure cooker cannot be used for dry method of cooking, grilling, roasting or frying and for foods which require manipulation during cooking.

Studies Conducted with Steam and Pressure Cookers:

Hood (1915)[40] conducted an elaborate study on pressure cooker versus fireless cooker for home use, with

regard to initial cost, durability, efficiency and scope of use, palatability, digestibility and saving of labour.

The foods were cooked by boiling and steaming. Steaming was done with utensils using 1. a ventilated sauce pan, 2. in a pressure cooker and 3. in a fireless cooker**. Gas was used as fuel in every case. The results showed that fireless and pressure cookers consumed less fuel than the ventilated sauce pan.

As for palatability, a 'closed-up-taste' was observed in the foods cooked with pressure and fireless cooker due to the tight covers. It was also found that pieces of cabbage cooked in the fireless and pressure cookers had turned to a dark, unpleasant colour while the pieces in the ventilated saucepan retained much of their natural colour.

Meat cooked in the pressure cooker had a delicious flavour, while that cooked in the fireless and ventilated saucepan had a flat flavour. A laboratory experiment conducted using these three types of utensils on digestibility of foods in vitro showed that the pressure cooked meat was readily digested when compared to the other two methods.

Cereals cooked in the pressure cooker had a nutty flavour and were light and fluffy in texture whereas those cooked in the fireless cooker were compact, firm,

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**Whitman (1951)[17] states that the fireless cooker is a device employing heat-insulating materials to prevent the loss of heat from the food and thus continue the cooking without the use of fire.

solid and lacked in flavour.

Experiments conducted by Denton (1919)[41] on changes in food values of vegetables due to cooking, indicated that maximum retention of food value was obtained by steaming. Maximum loss of soluble carbohydrates and proteins was encountered in boiling.

Another study was conducted by Peterson and Hoppert (1925)[42] on the loss of minerals using four methods of cooking namely steaming, pressure cooking, boiling in moderate quantity of water, and boiling in double the quantity of water. The loss of dry matter, crude protein, calcium, magnesium, phosphorous and iron were determined in each case. The loss of nutrients was least in steaming and greatest in boiling with excess water.

A study conducted by Devadas (1948)[43] on the effects of different methods of cooking on the ascorbic acid content and palatability of cabbage showed that a highly significant loss in ascorbic acid occurred in boiling with excess quantity of water.

Newton et al.(1948)[44] compared the effect of boiling, steaming and pressure cooking on the nutritive value of carrots. Boiling affected the ascorbic acid content of whole carrots similarly pared or unpared. Retention of ascorbic acid was high whether the unpared whole carrots were boiled in enough water to cover or in one half that amount.

Pressure cooking of carrots cut in cross-wise slices

gave 89 per cent retention of ascorbic acid.

A study was conducted by Krehl and Winters (1950)[45] on the effect of cooking methods on retention of vitamins and minerals in vegetable using twelve different vegetables representative of those used by the average homemakers. The fresh vegetables were first analysed for calcium, iron, phosphorous, thiamine, riboflavin, niacin, ascorbic acid and carotene. The various vegetables were cooked by four different cooking methods namely a. pressure cooking with ½ cup added water, b. with water to cover, c. with ½ cup water in a covered pan and d. without added water, that is, by the "waterless" method. The cooked vegetables were again analysed for all the minerals and vitamins. The data showed that the greatest retention of both minerals and vitamins was found when vegetables were cooked without added water, while the least retention was found when water to cover was used. Vegetables cooked in the pressure cooker or in a covered pan with ½ cup water occupied an intermediate position with respect to the nutritive losses.

Van Duyne et al.(1951)[46] made a comparative study on palatability and retention of reduced ascorbic acid in ten vegetables cooked in a tightly covered saucepan and in a pressure saucepan. The percentage retention of ascorbic acid in Brussels sprouts, cauliflower, spinach, asparagus, broccoli and cabbage was significantly higher when cooked to doneness in a tightly covered saucepan as compared to those in a pressure cooker.

Cooking of lima beans, peas and soya beans in pressure cooker resulted in a higher retention of ascorbic acid. The mean score for total palatability showed that asparagus, cauliflower and snap beans cooked in a tightly covered saucepan and broccoli, Brussel sprouts, lima beans, peas and soya beans cooked in a pressure saucepan were preferred.

Schlosser et al. (1957)[47] conducted some experiments on food yields and losses in pressure cooking. Fresh and frozen broccoli, potatoes, and dry lima beans were steamed at 10 and 15 pounds pressure in a steamer and boiled in a covered aluminum saucepan, to determine the relative cooking times, quality of product and usefulness of the steamer. Parts of older turkeys were steamed at 5 and 15 pounds pressure and braised in an oven at 325° F.

The cooking time for potatoes and frozen broccoli was not shortened by cooking at 10 and 15 pounds steam pressure while the cooking time for fresh broccoli and dry lima beans was much shorter in the steamer. Steaming turkey parts at 5 or 15 pounds required only about one fifth as much times as braising in an oven. The quality of the product varied with the type of food and the steam pressure used. Method of cooking appeared to have little effect on lysine content of dry lima beans or turkey parts.

Gordon and Noble (1959)[42] compared the effects of

three methods of cooking namely boiling, pressure saucepan and electric range on the flavour, colour and ascorbic acid retention of vegetables of the cabbage family. Vegetables cooked in boiling water were milder in flavour and greener in colour than those cooked by either of the other two methods. Cauliflower and cabbage cooked by electric range, and pressure saucepan methods were strong in flavour but broccoli cooked by electric range method was milder in flavour than that cooked by the pressure cooking method.

Mook et al.(1963)[23] refer to a study conducted by Peterson and Hoppert regarding the loss of mineral and other constituents from vegetables by boiling and steaming. The results indicated that the principal losses during cooking were those of soluble dry matter, proteins and salts of calcium, magnesium, phosphorous and iron. They concluded that steaming of foods helps to preserve more nutrients than boiling.

Kamalaveni (1961)[40] compared three types of cookers namely pressure cooker, steam cooker and an ordinary pan with a loose lid, with regard to time management, fuel consumption, care in handling the equipments and palatability of foods through the preparation of a standard meal consisting of parboiled rice, cow gram and potato.

The results showed that the mean time taken to cook the standard meal in the pressure cooker was 25 minutes 36 seconds, in the steam cooker 51 minutes and in the ordinary pan 92 minutes 24 seconds. On statistical analysis, the

differences in time taken between three cookers were found to be significant.

As regards the care and attention needed, the pressure cooker needed more careful handling, whereas the steam cooker needed the least attention. Significant differences were observed in foods cooked in different cookers.

Palatability Tests:

Any food preparation should be satisfactory in terms of appearance, flavour, odour, taste and texture for palatability. A scientific judgement of the quality and palatability of cooked foods is therefore important when evaluating equipment, and methods of cooking foods through experiments. This is especially when introducing new equipment, developing new recipes, and comparing methods of cooking. No equipment will be acceptable if it does not help to give palatable products, even though they may be time and money saving. Therefore, judging the acceptability of cooked products through a panel of tastes was taken as a criteria in the study.

Mason (1969)[50] states that the scoring of definite qualities of food may be done by two methods, subjective and objective. As the names imply, the subjective methods, depend to some extent upon the opinion of the judges, while in the objective methods, opinions and prejudices are largely eliminated. By the subjective method, the quality is determined largely through the sensory organs. The principal sensory properties effecting palatability of foods, expressed by Sweetman and Knoblloch (1964)[51] are, odour or aroma,

flavour which is a combination of taste and odour 'mouth-feel', appearance and temperature. Watts (1939)[52] says "Physiologically it seems clear that not only taste and smell but also touch (Mouthfeel) temperature and even pain contribute to the complex which is known as flavour or palatability in foods."

Sweetman and Mackeller (1954)[51] have reported that "the studies of BHNHRE (The former Bureau of Human Nutrition and Home Economics of the United States Department of Agriculture) and other researches have found that the best all around satisfactory way to test foods for flavour, texture and other properties is to serve samples to expert human judges and compare their verdicts." Mason (1939)[50] pointed out the easiest way to discover judges is to have a fairly large group of persons test foods with known differences in quality. One way of detecting inaccurate judges is to give at one time two identical samples along with another reasonably different. This is known as 'Triangular test.' It is a very common test for selecting the tasting panel. Love (1955)[53] states that the triangular test is often used to detect acuity of taste or smell in prospective panel members, in determining if differences exist between foods, and in testing the constituents or panel members throughout the study.

According to Love (1955)[53] the test unit in the triangular test consists of three food samples, two identical and one different. All the three samples are coded so

that they are known only to the person who is administering the test, and not to those administered. The members of the prospective panel are requested to identify the 'different' sample, and to give the reasons for their decision. After conducting the test for a series of time, their verdicts are studied and those who had been consistent in pointing out the 'different' sample correctly, are selected to constitute the panel.

Little (1953)[54] and Love (1955)[33] suggest that besides the ability to detect differences in the qualities of food, the person selected for the scoring test should be a person of average sensitivity, a high degree of personal integrity, ability to concentrate, intellectual curiosity and willingness to spend time for the scoring. They also stress, that the person should be healthy, have emotional stability and be free from colds, allergies and infections involving the sense organs.

Development of Score Cards:

For the objective assessment of the palatability of cooked products the use of score cards was considered to be the most appropriate method. Good and Seates (1954)[11] state that score cards as a group represent the most elaborate form of rating instrument for utilising judgements directly. The typical score card provides for more aspects or characterisation of the object to be appraised and has a definite number of points to be assigned to each item. In any score card a numerical scale along with descriptive

terms in a graded manner is necessary. In scoring test, according to Lowe (1955)[39] "the scorer assigns a numerical rating to single palatability factors. The scorer is expected to detect differences in the sample, if differences exist and to assign a quantity factor to these ratings."

III EXPERIMENTAL PROCEDURE

The experimental procedure consisted of two parts:

A. A survey of cookers used in the locality in order to select the cookers for the experiments.

B. Cooking experiments to compare the selected cookers with regard to expenditure of time and money and palatability of foods cooked in them.

A. Survey of cookers used in the locality in order to select the cookers for the experiments

A survey of cookers available in the locality, was conducted both in the markets and in the selected households. The purpose of the market survey was to find out the types of cookers available for sale in the market of Coimbatore, the materials of which they are made, their sizes, and their popularity in terms of demand. The purpose of household survey was to find out the different types of cookers used by the householders belonging to different income groups in Coimbatore, and the extent of their use.

These surveys were conducted in the following steps:

1. Selection of the method of survey, 2. Selection of sample of households, 3. Selection of the sample of shops in the market, 4. Development of the interview schedule, 5. Collection, analysis and interpretation of the data.

1. Selection of the method of survey:

The 'interview' method was chosen as the tool for the survey, because of its convenience and comprehensiveness which facilitated the obtaining of the necessary information as

reviewed on page 6.

2. Selection of the Sample of Households:

Fifty families, from the R.S. Puram suburban area, and Gandhipuram urban area, were selected for the household survey on random basis by taking every fifth family in the area. Sixteen of the fifty families belonged to the lower middle income group (Rs.300-600 per month), nine families to the middle income group (Rs.601-900 per month), thirteen families to the upper middle income group (Rs.901-1200 per month) and twelve families to the high income group (above Rs.1200 per month).*

3. Selection of sample of shops in the Market:

Ten shops dealing with stainless steel, aluminium and brass utensils were selected for the market survey. Two were located at Gandhipuram and two at R.S. Puram, and localities where the household survey was conducted, and the remaining six in the main market of Coimbatore town in order to compare the cost prevailing in wholesale-large shops as against the retail markets.

4. Development of the Interview schedule:

A comprehensive interview schedule as shown in Appendix I was framed, to elicit information from the

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* This basis of classification of the income range was done by the investigator.

households on following points: The types and materials of cookers used, reasons for using or not using the cookers, the various uses to which the cooker were put in terms of the food preparations, the materials needed for cleaning, and the fuel used for the cookers.

Another interview schedule was developed to obtain information from the shop keepers, regarding cookers available for sale and popularity in terms of demand made by consumers for each type of cooker.

5. Collection, analysis and Interpretation of the data:

The data collected from the survey were analysed and presented in Chapter IV.

B. Cooking Experiments Conducted to Compare the Selected Cookers with Regard to Expenditure of Time and Money and Palatability of Foods Cooked in them:

In conducting the cooking experiments the following steps were involved:

1. Selection of the experimental Meal,
2. Procurement of Equipment,
3. Purchase and Storage of Provisions,
4. Standardisation of all the Procedures involved:
    a. Standardisation of receipes,
    b. Conducting palatability test,
    c. Measuring fuel consumption and

4. Planning time

5. Care of the Cookers.

1. Selection of the experimental Meal:

The quantities of foods required for a day's diet for a beginning family* were calculated according to the allowances recommended by Aykroyd et al (1961) as shown in Table I.

TABLE I

RECOMMENDED DAILY ALLOWANCES OF CALORIES AND SOME ESSENTIAL MATERIALS FOR A BEGINNING FA-

FAMILY DOING SEDENTARY WORK

	Calories	Pro-tein gms.	Iron mgms.	Calcium gm.	Vita-min A I.U	Vita-min C mg.
Man	2400	68	20	1.00	3000	50
Woman	2100	47	25	1.00	3000	50

Using the amounts given in Table I the day's menu was planned as shown in Table II.

* Beginning family - Goodyear and Hiebr (1963) refer to 15e beginning family as the young couple.

TABLE II

MENU FOR THE WHOLE DAY FOR AN ADULT

Meal	Food Preparations
Breakfast	Rice 'puttu' Green gram 'kadhamba' Banana Coffee
Lunch	Rice Greens 'poguth' Ladies finger 'sambar' Tomato salad Butter milk Guava
Tea	Ragi leaf cake with coconut Tea
Dinner	'Chappathi' Tomato dhal masseel Carrot salad Sago 'payasam'

As can be seen from Table II, the menu included commonly used preparations in south India, while providing at the same time nutritious preparations such as ragi leaf cake within the cost of Rs. 1.87nP. The experimental meal selected was breakfast. Since this study involved steaming as a method of cooking, rice 'puttu', green gram 'kadhamba' and banana, all of which could be steamed were included in the menu.

The selection of recipes for the experimental meal involved conducting a series of preliminary experiments with

various preparations of rice flour, green gram and green peas which could be steamed. Among the rice preparations, 'Kozhukkattai', 'appam' and 'puttu' were tried and with green gram and green peas, curry and 'kozhambu' were tried.

Out of the rice preparations, 'puttu' was selected for the following reasons: It could be steamed in all the selected cookers, it was a common breakfast item in South India as revealed by the household survey and it was easy to prepare.

Among the pulse preparations, green gram 'kozhambu' was selected because of its availability throughout the year, investigator could purchase in one lot and keep it throughout the experiment and its popularity in south Indian homes. Banana was included since it is used with 'puttu' as a side-dish. The recipes chosen for the break-fast were standardised by conducting a series of experi-ments with various quantities of the ingredients and comparing the scores awarded by a panel of four experienced judges. The finalised recipes are given in appendices II, III and IV.

2. Procurement of equipment:

The equipment needed for this study were: a. cookers, b. stoves, c. serving dishes, and d. measuring devices.

a. Cookers: On the basis of the information obtained from

the market and household surveys, as mentioned on page 26, three different types of cookers were selected for this study along with another 'devised' by the investigator using a midget for steaming. This fourth cooker was considered important from the point of cost for poor class families.

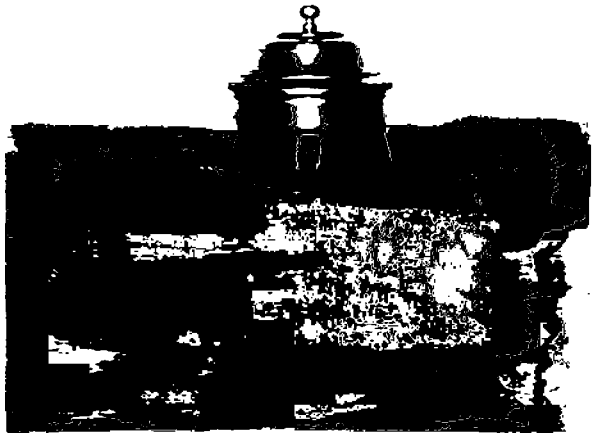
Two steam cookers namely 'idli' steamer costing Rs. 32.50nP. and a common type of steam cooker costing Rs. 48.50nP. as shown in Figure 1 and 2 respectively, were selected.

A pressure cooker costing Rs.110/- was selected for the study as shown in Figure3.

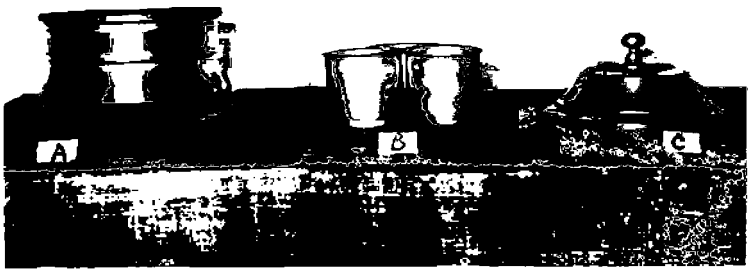
The fourth steam cooker selected for the study was an 'improvised' mud steamer costing 94 nP. was assembled by the investigator as shown in Figure 4.

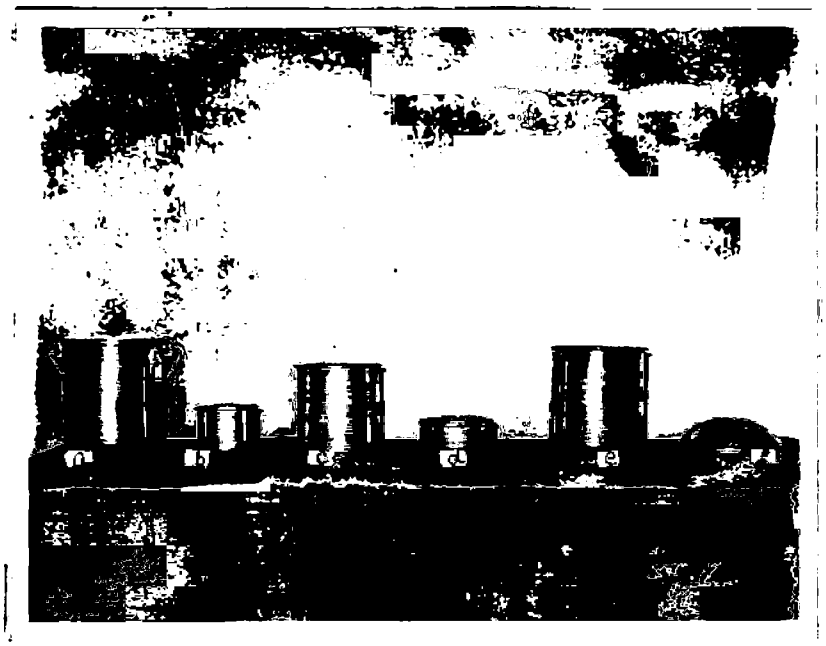
After selecting the types of cookers to be used, it was necessary to ensure whether or not uniformity in their sizes was essential. Therefore, a series of preliminary experiments were conducted to find out whether changes in the volume of inner and outer utensils would affect the time taken for cooking. The results showed that the time taken for cooking was affected only if there is large difference in the quantity of food to be cooked or the difference in capacity between the outer utensils and the inner utensils is very high. Therefore, as far as possible the volume of the pressure cooker as the standard. similarly, the volumes of the inner utensils were also identical in all the cookers

FIGURE 1.



PARTS OF THE COOKER





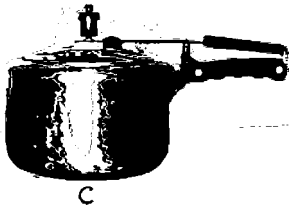
Description	Material	Volume in ml.
a. The utensil for producing steam ..	Brass	3050
b. Five inner utensils to hold foods to be cooked (Only three were used for cooking experiments.)		
b.	Alloy	610
c.	Alloy	3045
d.	Alloy	630
e. Covering vessel	Brass	--
f. Lid for covering the cooker when packed	Brass	--
Frying pan for seasoning*	Iron	--
Tongs*	Iron	--
Spoon*	Alloy	--

The volumes of the inner containers are varied due to the design of the cooker.

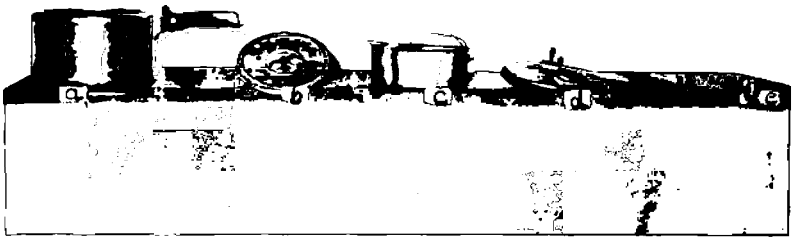
Operation of the cooker: Two and a half cups of water was taken into the outer utensil of the cooker to produce steam. The inner container with the largest volume was used for the preparation of 'puttu' and the container with the smallest volume was used for green gram 'kushambu' and the container with intermediate volume was used for steaming banana. The container with the smallest volume was placed in the outer utensil first; over this was placed the container with the largest volume. The vessel with the banana was placed over this and finally the cooker was covered with the covering vessel and placed on the

*These parts are not shown in the Figure.

FIGURE 3.



PARTS OF THE COOKER.

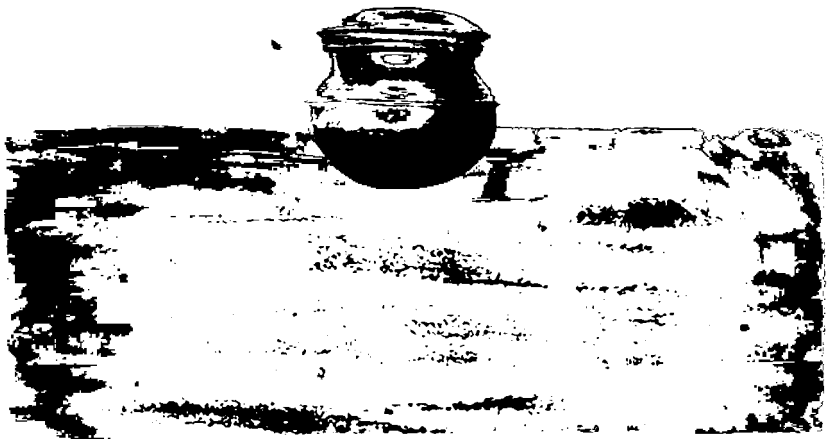


and automatically.

Operation: Two and a half cups of water were taken in the cooker. The rack was placed inside to keep the inner containers. The inner containers were filled with the foods to be cooked and placed on the rack. The cooker was closed by first bringing together the arrow mark on the cover with that of the body of the cooker to facilitate proper fitting of the cover. Then the balance pivot was placed in the depression of the cooker handle and the handles were pressed together to allow cover hook to fasten over metal catch. The cooker was then placed on the stove over a steady blue flame. On the escape of steam through the vent pipe the vent weight was placed on it and the heat was reduced. After the standardised time, the cooker was removed from the stove and was cooled by lifting of the vent weight with a pair of tongs. To open, the handles were pressed together and hook was allowed to swing free from the handle catch. The cover was turned so that the arrows were brought together once again and was tilted slightly to remove.

'Improvised Cooker.' The parts of the improvised cooker as shown in Figure 4 are given in page 41.

FIGURE 4.



PARTS OF THE COOKER.

Description	Material	Volume in ml.
a. A mud vessel ..	Earthenware	2815
b. A rack ..	Aluminium	—
c. Three tin containers..	Tin	555 each.
d. Close-fitting lid ..	Earthenware	—

The inner containers were cylindrical resembling the containers of the 'idli' steamer.

Quantities of the cookers: The inner containers were filled with the foods to be cooked. Three cups of water were poured into the mud vessel and the rack was placed to hold the inner containers. The three inner containers were then kept, and the cooker was closed with the lid.

A long strip of cloth one inch width, enough to go round the lid was taken. A dough of 'maida' flour was prepared and smeared uniformly along the full length of the strip of the cloth. This was stuck all along the circumference to minimise the escape of steam during cooking. At the end of the cooking period, the cooker was removed from the stove and the cloth was removed.

Quantity of water used in the outer utensils: The quantity of water used in the outer utensils of all the cookers except mud steamer for producing steam was two and a half cups in order to keep the amount of steam produced constant. As the mud steamer took longer time for cooking, three cups of water had to be used in the case of 'improvised' mud steamer.

b. Stoves for cooking: Preliminary experiments were conducted with different types of kerosene stoves and

and four kerosene stoves, identical in all respects were selected for use with the four cookers. They were chosen since kerosene could be measured and the flame easily regulated and controlled and also a steady and continuous supply of heat could be maintained.

The stoves selected for the experiment were similar to those selected by Pushpa (1982)[87] and Shantakumari (1982)[88] for their study.

Regulation of stoves: In order to regulate the proper working of the stoves, wicks of the same length (13 inches) were used for the four stoves at the start of the experiment. 1,200 ml. of kerosene were poured in all the four stoves to maintain the level of kerosene constant in the combustion chamber.

The regulation of the use of stoves also entailed the following steps:

i. The rotation of the four stoves and cookers during the cooking experiments was done in order to minimise any error which might occur due to qualities which were not measurable.

The stoves were marked A B C D and the four cookers were marked 1, 2, 3, 4 respectively. During the experiments, these stoves and cookers were rotated as shown in Table XII.

TABLE XXI

ROTATION OF STOVES AND COOKERS

Replicates	Stove A	Stove B	Stove C	Stove D.
1.	Cooker 1	Cooker 2	Cooker 3	Cooker 4
2.	Cooker 4	Cooker 1	Cooker 2	Cooker 3
3.	Cooker 3	Cooker 4	Cooker 1	Cooker 2
4.	Cooker 2	Cooker 3	Cooker 4	Cooker 1

ii. Regulation of flame: Regulation of the flame during the cooking experiments was done according to the procedure followed by Pushpa (1968)[88] and Shantakumari (1968)[89].

c. Serving dishes: The dishes selected for serving the cooked foods to the panel of judges consisted of twenty plain white porcelain quarter plates, five plain glass tumblers and twenty stainless steel teaspoons. The plain, white porcelain plates were selected as they do not react with foods or impart any odour to them and to enable the judges to observe clearly the colour of the foods served and to discern the differences if any.

d. Measuring devices: The measuring devices used in the study consisted of:

A set of standard aluminium cups for measuring water, a Hanson's Dietetic Scale graduated from 0 to 500 grams for measuring rice flour, green gram, banana, chilly powder, salt, onion, mustard and refined oil, a time piece with seconds hand for registering the time taken by each cooker, an Avery balance weighing to the nearest gram for weighing the quantity of kerosene consumed by the stoves before and

after cooking.

3. Purchase and Storage of Provisions:

All the dry provisions such as rice, green gram, chilly powder, mustard and sugar were bought in bulk based on the calculation in terms of the amounts required for the number of trials. It was estimated that 36 trials would be needed and the amounts purchased are shown in Table IV.

TABLE IV

QUANTITY OF PROVISIONS PURCHASED

Provisions		Quantity (Metric Standard)
Raw rice(Kgm.)	..	18 K
Green gram (Kgm.)	..	7.5
Sugar (Kgm)	..	1
Chilli powder (gm)	..	500
Mustard (gm)	..	50
Refined oil (Kgm)	..	1.35
Bananas	..	2 bunches

The rice, green gram and mustard were cleaned and stored in airtight containers; sugar, chilly powder and oil were stored in clean dry bottles with tight-fitting lids and labelled. Two bunches of bananas at different stages of ripeness were purchased in one lot to last for sixteen days, which constituted the duration of the experiments. Coconuts and onions were purchased on alternate days to ensure freshness. As for the fuel, kerosene was

purchased in a sealed tin of 24 bottles capacity.

4. Standardisation of all the Procedures:

a. Standardisation of recipes: Standardisation of 'puttu', 'kuzhambu' and banana were done as follows:

i. 'puttu': Preparation of raw rice flour: For every taste panel that was given, four cups of clean raw rice were washed twice and soaked in eight cups of water for 45 minutes. The excess water was removed from the rice using an aluminium sieve. Home pounding method was adopted to pound the rice as this is the most common method by which rice is prepared for 'puttu' in South India. 'Ural' and 'ulakkai', which were the equipment used for pounding the rice are shown in Figure 5. The rice was pounded and sifted with a fine flour sieve. This process was repeated alternately till the maximum amount of flour was obtained. The whole quantity of flour was transferred to a clean, dry, earthenware vessel for broiling the flour. The reason for selecting the earthenware vessel for the purpose of broiling was that the preliminary experiments showed best results when compared with the other materials used for similar purpose. Broiling is one of the methods of cooking. Hamilton and Daw (1967)[59] define broiling as cooking "by direct exposure to the source of heat, which may be burning coal, wood charcoal, gas or oil or the red hot units of an electric range." Lindsay and Treat (1963)[60] point out that the heat obtained by direct heat is

a

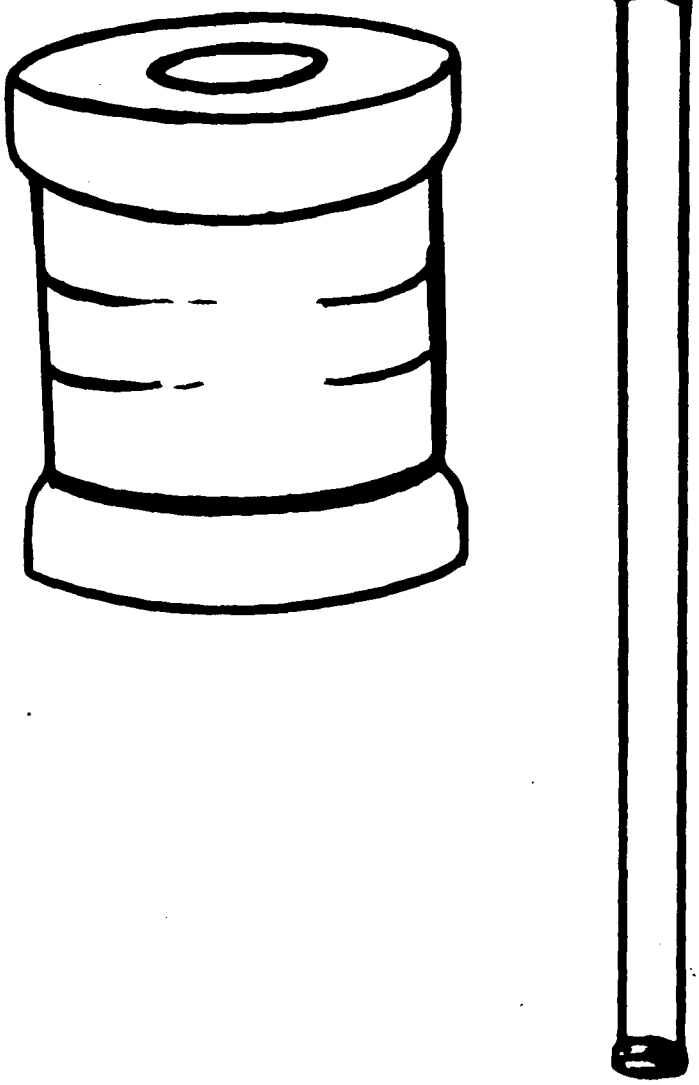


FIGURE-5

a. URAL

b. ULAKKAI

concentrated and cooking takes place rapidly. Holt (1956)[85] considered this method to be one of the most digestible and simple ways of preparing food, as it is free from liquid, water or fat during the process of cooking and is neither sodden nor greasy.

Broiling the flour: A kerosene stove was lighted and when the flame was blue and steady the earthenware vessel with flour was kept on the stove and stirred constantly. A stainless steel ladle was used for stirring the flour to prevent it from sticking to the bottom of the vessel. Broiling was done for 12 minutes as it was found from the preliminary experiments to give an acceptable product. The vessel was then removed from the fire and the flour that remained in the sieve was again broiled in the same vessel for 1½ minutes as the lumps were not broiled uniformly. They were ground finely in a grinding stone and mixed with the already sifted flour. The whole quantity of flour was used in the preparation of 'puttu' for one tasting panel.

The method given in Appendix II was adopted for the preparation of 'puttu.'

ii. Green gram 'husking': Soaking of the green gram: 120 grams of cleaned green gram was taken and soaked in two cups of water for 4½ hours, before the commencement of the experiment. According to West and Wood (1967)[91] and Love (1968)[89] soaking of dried legumes replaces the moisture lost during drying and helps to shorten the

cooking time.

Extraction of coconut milk: Coconut was scraped using the coconut scraper and the scrapings were ground lightly in the grinding stone, shown in Figure 7, to facilitate the extraction of the maximum amount of milk. The ground coconut scrapings were transferred into a stainless steel vessel and 1½ cups of water were added. The milk was extracted by passing through a strainer.

Steaming of green gram 'kuzhambu': Steaming was done for four minutes. Green gram 'kuzhambu' was prepared according to the method given in Appendix III.

iii. Steaming of banana: Two well riped bananas were taken and cut into pieces of 1½ inches in length weighing 35-40 grams and steamed.

All the ingredients for preparing 'puttu', green gram 'kuzhambu' and banana were mixed separately as given in Appendices II, III and IV. The four cookers were filled with equal amounts of ingredients and steaming was done simultaneously for the standardised period of time as given below:

'Idli' steamer	.. 25 minutes
Steam cooker	.. 41.75 minutes
Pressure cooker	.. 8 minutes* (at 15 pounds pressure)
Improvised mud steamer	.. 46.8 minutes

The investigator was also interested in finding out

*This time was noted after putting the vent weight on the vent pipe, when the steam started escaping.

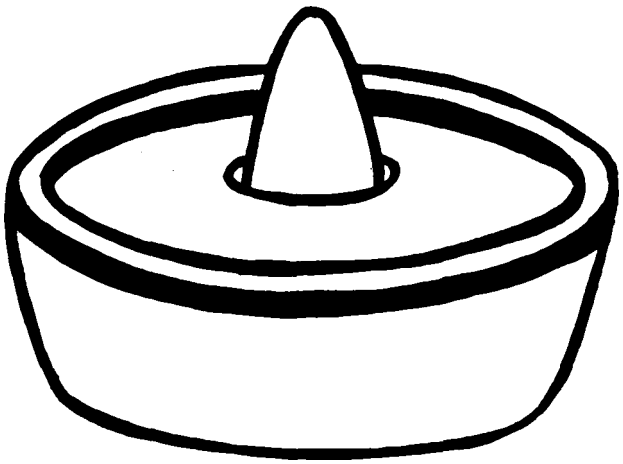


FIGURE 6

GRINDING STONE

(ATTUKKAL)

whether reducing the pressure to ten pounds in the case of pressure cooker would give a more acceptable product. Therefore, another experiment was conducted to compare the products, steamed in pressure cooker, one at 15 pounds pressure for eight minutes and the other at 10 pounds pressure for ten minutes. The same procedure was followed as given in Appendices II, III and IV. The findings of the experiments are given on page , and results are discussed.

b. Conducting Palatability Tests: Taking all the factors reviewed on pages 23 and 24, for selecting the judges for tasting panel, the Triangular test was administered to ten Home Science post graduate students and staff members of Sri Avinashilingam Home Science College. They fulfilled all the qualities described by Love, (1955)[53] They were interested in the study, willing to cooperate and spend time for judging the products.

The test was conducted as follows: Two samples of 'puttu' were cooked in a pressure cooker and in the 'idli' steamer. Two of the samples were served from the pressure cooker and one sample from the 'idli' steamer. The samples were served into white porcelain plates in identical quantities which were sufficient for the purpose of testing. All the three samples were presented to the scorers simultaneously, arranging the plates in a random order. The score card as shown in Table V was given to each judge to mark the different sample and the reason

for marking so.

The Triangular test and the subsequent testing of the experimental samples were conducted in a quiet, comfortable place with a good supply of fresh air and light in order to avoid any interruptions or distractions. The judges were seated far apart so that any influencing of the scores through facial expressions and discussions was made impossible.

TABLE V

SCORE SHEET FOR USE IN THE TRIANGLE TEST

Instructions to members:	Among the three samples given, two are identical and one is different. Kindly mark which is the different sample, and write how it is different. After testing each sample, please drink little water and pause a while to remove the taste of that sample. Then taste the next sample.		
To be filled by the investigator:	Date.	No.	Sample.
To be filled by the judges:	Different samples		How is it different
Signature of the judge.			

According to the standards given for scoring cereals by Child and Miles (1928)[61] the qualities chosen to be judged in 'puttu' were appearance, doneness, odour and taste. The qualities judged for green gram 'kushumbu' were colour, consistency, odour, taste and doneness and

for banana; colour, doneness, odour, tenderness and taste.

The score cards were developed separately for 'puttu' green gram 'kuzhambu' and banana on a five point scale as shown in Appendices VI, VII and VIII. The scorer marks the score she wishes to assign to one particular quality in the descriptive score card given to her. Four replicates were done for the scoring tests.

e. Measuring fuel consumption: For the measurement of kerosene consumption, the following procedure was adopted.

Before the commencement of the cooking, each stove was weighed separately, after removing the stand, stove cap, inner and outer cylinders, in an Avery scale. The initial level of kerosene was kept constant in all the four stoves throughout the experiments to minimise the error which may arise due to difference in kerosene level. Each stove was weighed before lighting and at the end of the cooking period. The kerosene consumption was obtained by subtracting the second reading from the first.

d. Cleaning the steamers:

i. Cleaning materials: The materials used to clean the outer vessels of 'idli' steamer and the steam cooker were tamarind, sifted ash and coconut fibre. For this purpose, 1/8 kilogram of tamarind was bought in one lot, 200 grams of ash was collected from the hostel kitchen and coconut fibre from the coconut used for the preparations. All these were stored separately near the washing area.

The cleaning material used for the pressure cooker was soapnut powder as the data obtained from the household survey showed that soapnut powder is one of the common cleaning materials used for scrubbing the pressure cooker. The mud vessel also was cleaned with soapnut powder and coconut fibre. The inner utensils of all the cookers were cleaned with soapnut powder and coconut fibre as the preliminary experiments showed good results. A clean piece of cloth was used for wiping of the cookers after washing.

ii. Scrubbing time:The time taken to scrub each cooker was noted and given in Table XVII. The standardised procedure adopted for this was as follows:

Immediately after cooking, the inner utensils of all the cookers were soaked in water for 15 minutes. The outer utensils and lid of 'idli' steamer and the steam cooker were first smeared with tamarind pulp dipped in water. Equal amounts of tamarind, ash and coconut fibre were taken to scrub both the utensils. Three grams of soapnut powder was used to scrub the outer utensils of pressure cooker and mud vessel. Two grams of soapnut powder was used to scrub the inner utensils of each cooker. After scrubbing each cooker was rinsed in soft water.

5. Care of the Cookers:

After washing, each cooker was wiped dry and kept open to obtain a good circulation of air to prevent the cooking

odours if sticking on to the utensils. In the case of inner utensils of rice steamer, three drops of refined oil was smeared to the inner portions after wiping dry to prevent the utensils getting rusted. After washing the pressure cooker, care was taken to clean the vent tube with tiny brush as suggested by Peet (1968)[62] and Beveridge (1968)[63]. The gasket was removed from the place and thoroughly washed and removed all the food particles sticking on to it. The vent weight was removed from the vent pipe and checked for cleanliness and replaced.

IV. RESULTS AND DISCUSSIONS

The results of the experiments conducted are discussed under the following heads:

A. Survey on cookers available in the market and used in the households as basis for selection of the cookers for this experiment.

B. Cooking experiments with four selected cookers.

A. Survey on Cookers Available in the Market and Used in the Households as Basis for Selection of the Cookers for this Experiment:

The data collected through the survey are presented and discussed under the following heads:

1. Market survey,
2. Number and percentage of families using the different types of cookers,
3. Number and percentage of families using the cookers for various food preparations,
4. Frequency of use of the different types of cookers,
5. Reasons given by the homemakers for using the different types of cookers,
6. Reasons given by the homemakers for not using different types of cookers,
7. The cleaning materials used for different types of cookers,
8. Types of fuels used with the different types of cookers.

1. Market Survey

The market survey showed that all the ten shops surveyed had on sale 'improvised cookers', made of iron, stainless steel and aluminium, and 'idli' steamers made of different materials such as stainless steel, aluminium and brass. The cost of the cookers varied with the size, weight and material. Only four shops in the main bazaar had pressure cookers and steam cookers for sale. It was not possible to obtain accurate information on the number of cookers sold by each shop because of reluctance of the shopkeepers.

2. Number and Percentage of Families Using the Cookers for Various Food Preparations

The number and percentage of families out of the fifty families surveyed using the different types of cookers for various cooking purposes is given in Table VI.

TABLE VI

NUMBER AND PERCENTAGE OF FAMILIES USING THE DIFFERENT TYPES OF COOKERS

Types of cookers	Number	Percentage
'Idli' steamer	36	72
'Improvised' cooker*	15	30
Steam cooker	10	20
Pressure cooker	8	16

It may be noted from Table VI, that the majority of

*Improvised cooker: The improvised cooker as shown in Figure is deep iron pan in which utensils containing the foods to be cooked are placed over boiling water and is covered with a brass or aluminium lid.

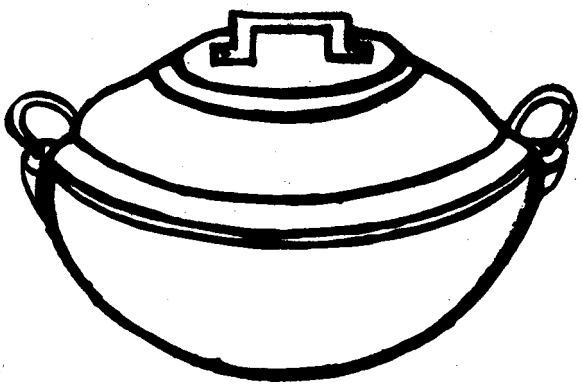


FIGURE 7
IMPROVISED COOKER

the families possessed 'idli' steamer while only eight families had pressure cookers. Out of the 36 households using 'idli' steamer, five had in addition, steam cooker, three pressure cooker and two improvised cooker. Among the 15 families using the improvised cooker, two had steam cooker as well. Among the eight families who had pressure cooker, a steam cooker was found. It was observed that the 'improvised cooker' and 'idli' steamer were used by families of all income groups while the pressure cooker and steam cooker were used only by families of middle income and above middle income groups for the obvious reason that the pieces of equipments were costly.

3. Number and Percentage of Families Using Cookers for Various Preparations

The various kinds of food preparations for which the different types of cookers were used in the households are given in Table VII, classifying the food preparations under seven categories.

TABLE VII.

NUMBER AND PERCENTAGE OF FAMILIES USING THE DIFFERENT TYPES OF COOKERS FOR VARIOUS FOOD PREPARATIONS.

Cookers.	No. of families using the cooker	For the Preparation of													
		Rice.		Dhal		Vegetables		Puttu, Sevai Kombuttai, Iddli, Pongal, Upma.		Custard & Pudding		Meat		Grain	
		Number	Per centage.	Number	Per centage.	Number.	Per centage.	Number.	Per centage.	Number.	Per centage.	Number.	Per centage	Number	Per centage.
Iddli Steamer	36	15	41	12	33	8	22	16	44	2	5	-	-	-	-
Improved.	15	9	60	6	40	7	45	10	66	-	-	-	-	-	-
Pressure Cooker.	8	8	100	8	100	8	100	1	12	3	37	2	25	2	25
Steam Cooker.	10	8	80	8	80	7	70	1	20	-	-	-	-	-	-

The data given in Table VII show that the various types of cookers were used for preparing seven items in the households. All the families who had the pressure cookers used it for cooking rice, dhal and vegetables. Some of them used it for preparing custards, puddings and meat also. Out of the ten who had steam cooker, eight families used it for cooking rice and dhal and seven used it for cooking vegetables. However, when compared with the 'idli' steamer and the 'improvised' cooker, the use of steam cooker was limited to only cooking the breakfast preparations. The 'improvised' cooker was used by the majority of the families, who adopt this device for cooking breakfast preparations and rice. Out of the 16 families who had this cooker, seven used it for cooking vegetables and six used it for cooking dhal. The 'idli' steamer was used by 16 families out of the 36 who had this cooker, mainly for cooking breadfast preparations. A few were using it for cooking rice, dhal and vegetables also.

These findings formed the basis for the selection of the foods to be cooked in this study as indicated on page 32.

4. Frequency of Use of the Different Types of Cookers:

The frequency of the use of the different types of cookers in the various households in terms of its use daily, on alternate days and rarely, is given in Table VIII.

TABLE VIII

FREQUENCY OF USE OF THE DIFFERENT TYPES OF COOKERS.

Cookers	Number of families possessing	Daily		Alternately		Rarely	
		Number	Per centage	Number	Percentage	Number	Percentage.
'Idli' Steamer	36	30	83	2	5	4	12
'Improved' Cooker	15	12	80	1	8	2	12
Pressure cooker	6	6	75	-	-	2	25
Steam Cooker	10	7	70	-	-	3	30

The data presented in Table VIII show that the 'idli' steamer was used daily by 83 percent (30) of the families, on alternate days by 5 per cent (2), and rarely by 12 per cent (4). The 'improvised' cooker was used daily by 80 per cent (12), on alternate days by 8 per cent (1), and rarely by 12 per cent (2). The pressure cooker was used daily by 75 per cent of the families and rarely used by 25 per cent. The steam cooker is made use of daily by 70 per cent of the families and rarely by 30 per cent of the families. Thus all these steamers were used on a daily basis by those who possessed them.

6. Reasons Given by the Homemakers for Using the Different Types of Cookers:

The various reasons given by the homemakers for using the different types of cookers are given in Table IX.

TABLE IX

REASONS GIVEN BY THE HOUSEMAKERS FOR USING THE DIFFERENT TYPES OF COOKERS

Reasons	'Idli' steamer	Steam cooker.	Pressure cooker	'Improvised' cooker	Total entries or reasons
	Number of housewives mentioning				
1. Convenient	25	15	7	13	65
2. Labour saving	21	8	7	8	54
3. Time saving	26	6	8	9	49
4. Foods cooked are palatable	16	5	5	14	40
5. Economic	19	6	8	6	36
6. Habit	14	-	-	3	17
7. Conserving nutrients in foods cooked	10	5	4	5	24
TOTAL ENTRIES ..	140	40	36	60	286
Total number of families using each cooker	26	10	8	15	59

From Table IX, it is clear that seven important reasons were mentioned by the housemakers for using the various types of cookers. Of these, convenience was expressed by 65 entries. Labour saving and time saving factor were mentioned by 54 entries and 49 entries respectively, contributed mainly by the idli steamer. The other reasons given according to the order of importance were flavour (40 entries), economic (36 entries), nutritious (24 entries) and habit (17 entries) contributed mainly by idli steamer. Out of these saving of time, economy and

palatability were chosen as the experimental variables with regard to frequency and possibility for experimentation.

6. Reasons Given by the Homemakers for not Using Different Types of Cookers

The reasons given by the homemakers for not using the different types of cookers are summarised in Table X.

TABLE X

REASONS GIVEN BY THE HOMEMAKERS FOR NOT USING THE DIFFERENT TYPES OF COOKERS

Reasons	'Idli' steamer	Steam cooker	Pressure cooker	'Improvised' cooker	Total entries
1. Cost	8	18	21	-	41
2. Foods cooked are not palatable	16	13	15	3	46
3. Limited capacity	23	18	23	4	68
4. Fuel problem	3	4	3	3	13
5. Lack of information regarding the cooker	8	12	20	12	52
6. 'Not necessary'	11	10	11	10	42
7. Use violates customs and traditions	-	-	13	-	13
8. Poor appearance	-	-	-	5	5
9. Difficulty in manipulation	-	6	21	-	27
10. Do not like	-	1	-	2	3
TOTAL ENTRIES ..	81	76	127	[illegible]	304

It can be seen from Table X that the most important

reason mentioned by the homemakers for not using the different types of cookers were the limited capacity of the cookers. Lack of information was the chief reason mainly with regard to pressure cooker, non-palatability of foods cooked and cost are the inhibiting reasons for the non-use of pressure cooker and steam cooker and idli steamer. Other reasons expressed were difficulty in manipulation in the case of both pressure and steam cookers and violating the customs and traditions in the case of pressure cooker and the poor appearance of the cooker for the improvised cooker and dislike for steam cooker and improvised cooker.

7. Types of Fuel Used with Different Types of Cookers:

The types of fuel used in the households with different types of cookers are presented in Table XI.

TABLE XI

TYPES OF FUEL USED WITH DIFFERENT TYPES OF COOKERS

Cookers	Fuels used
'Idli' steamer	.. Kerosene and firewood
'Improvised' cooker	.. Kerosene, firewood and charcoal.
Steam cooker	.. Kerosene, firewood and charcoal.
Pressure cooker	.. Kerosene and electricity.

From Table XI, it is observed that only a few types of fuels are commonly used for cookers namely, kerosene, firewood, charcoal and electricity. Of these only kerosene and electricity are used as fuels for pressure cooker.

5. The Cleaning Materials Used for the Different Types of Cookers.

The data collected on the cleaning materials used for different types of cookers showed that tamarind and ashes are the most commonly used materials for cleaning the 'idli' steamer and steam cooker. Bengal gram powder and soapnut powder were also used in some families. For cleaning the improvised cooker, mainly soapnut powder and bengal gram powder were used. 'Vim' was the cleaning material commonly used for cleaning the pressure cooker. Soapnut powder, bengal gram powder and soap powder were used to some extent for the purpose.

B. Cooking Experiments with the Selected Cookers:

As mentioned on page 32, four cookers namely 'idli' steamer, steam cooker, pressure cooker and improvised sand steamer were selected for the study. The results of the various experiments conducted with the four cookers are discussed under the following heads:

1. Time taken for cooking the breakfast,
2. Palatability of the foods cooked,
3. Cost of fuel, and
4. Time taken for cleaning after cooking.

The analysis of variance with the 'F' ratio and 't' test were used in the statistical analysis of all the data to establish the significance of differences obtained in the experiments.

'F' ratio is explained by Snedecor (1946)[64] as a ratio of the variances (or mean square) between the experimental variables and within the replicates. If P, the probability of its occurrence by chance, is less than 0.01, it indicates that the differences obtained in the experiments as a whole are very significant. The 't' test is applied by method suggested by Garrett (1958)[65] in order to find out which of the differences between the four means are significant. According to the given method, the standard error for the data presented in each table is multiplied by the relevant 't' and the minimum differences required for significance is determined. The minimum difference required at one per cent level is indicated by $D_{0.01}$ and at five per cent level is indicated by $D_{0.05}$.

1. Time Taken for Cooking the Standard Breakfast Using the Four Selected Cookers:

The total time taken for cooking the standard breakfast using the four selected cookers is presented in Table XII.

TABLE XII

TOTAL TIME TAKEN FOR COOKING THE STANDARD BREAKFAST USING THE FOUR SELECTED COOKERS

Replications	Time in minutes				Analysis of mean differences
	'IDLI' steamer	Steam cooker	Pressure cooker	'Improvised' mud steamer.	
1.	38.0	41.0	18.0	46.0	D_I and P = -18.0**
2.	37.9	41.1	18.2	46.8	D_S and I = -3.08
3.	38.1	41.1	18.1	46.00	D_I and M = 8.08
4.	38.0	41.1	18.1	46.0	D_S and P = -22.9**
Total	152.0	164.3	72.4	182.80	D_S and M = -5.05
Mean	38.0	41.75	18.1	46.95	D_P and M = 28.85**

F = 3.1145 $t_{0.05}$ = 2.18 $t_{0.01}$ = 3.06 $D_{0.01}$ = 3.7487
$D_{0.05}$ = 2.7436

Note: The following abbreviations are used in Table XII:

I - Idli steamer P - Pressure cooker

S - Steam cooker M - 'Improvised' mud steamer.

** Indicates significance at 1 per cent level.

The results shown in Table XII indicate that the improvised mud steamer took the maximum time to cook, followed by the steam cooker and 'Idli' steamer, while the pressure cooker had taken the minimum time. The reason for pressure cooker taking minimum time for cooking is because in the pressure cooker, foods are cooked at higher temperatures resulting from steam under pressure whereas in the ordinary

steam cookers, foods are cooked at 212° F (the temperature of steam at N.T.P). It was also observed that there were significant differences beyond one per cent level in the time taken for cooking between all the four cookers. (Vide Appendix IX) Moreover, the time taken in the improvised mud steamer was one and a half times more than that of the time taken by the pressure cooker. According to De Sagar (1962)[64] clay, which is a poor conductor of heat, is the chief component of both earthenware (mud) and porcelain. Thus the poor conductivity of mud must have required a longer time for cooking.

2. Palatability of the Foods Cooked Using the Four Cookers:

The palatability of the foods cooked is discussed individually and collectively in the following pages.

a. 'Puttu': Table XIII gives the mean scores and the analysis of mean differences for palatability of 'puttu' cooked using the selected cookers.

TABLE XXI

MEAN SCORES FOR PALATABILITY OF 'PUTTU' COOKED USING THE FOUR COOKERS

Qualities	'Idli' steamer	Mean cooker	Pressure cooker	'Improved' steamer	Level of significance
	Mean of replicates				
1. Flour separateness	4.0	3.9	3.1	3.85	F = 3.46*
2. Colour	4.5	4.5	4.3	4.4	F = 0.85
3. Denseness	3.5	3.25	3.35	4.15	F = 3.48*
4. Odour	4.5	4.1	4.3	4.6	F = 1.23
5. Taste	3.9	3.5	3.7	4.1	F = 1.56
Total	20.40	19.25	18.7	21.10	
Mean	4.10	3.87	3.74	4.22	

Mean Differences:

	I and S	I and P	I and M	S and P	S and M	M and P
Flour Separateness	0.1	0.9**	0.15	0.80**	0.05	0.75*
$D_{0.01}$=0.80						
$D_{0.05}$=0.60						
Denseness	0.5	0.10	-0.65*	0.10	-0.90**	0.80*
$D_{0.01}$=0.8144						
$D_{0.05}$=0.6134						

From Table XXI, the average scores obtained for the palatability of 'puttu' in all the four cookers, it was found that the 'puttu' prepared using the 'idli' steamer obtained the maximum scores and that prepared using the

In the pairs of cookers the one which is superior in scores is presented first. When the second cooker is superior, the difference is indicated by negative sign.
* Indicates significance at 5 per cent level.

TABLE XIV

MEAN SCORES FOR GREEN GRAM 'KUZHAKKU' COOKED USING THE FOUR COOKERS

Qualities	'Idli' steamer	Steam cooker	Pressure cooker	'Improvised' steamer and steamer	Level of significance.
	Mean of replicates				
1. Colour	4.35	4.30	3.90	4.2	F = 0.36
2. Consistency.	3.40	4.20	3.95	4.25	F = 6.89**
3. Odour	4.20	4.00	4.25	4.7	F = 2.29
4. Doneness	4.45	4.30	4.50	4.60	F = 4.04
5. Taste	4.0	4.0	4.15	4.4	F =17.00**
Total	20.30	21.8	20.30	22.15	
Mean	4.06	4.36	4.1	4.43	

Mean Differences:

	I and S	I and P	I and N	S and P	S and N	N and P
Consistency $D_{0.01}=0.86$ $D_{0.05}=0.70$	−0.9**	−0.55	−0.85*	0.35	0.05	0.3
Taste $D_{0.01}=0.21$ $D_{0.05}=0.16$	0	−0.15	−0.4**	−0.15	−0.4**	0.25**

From Table XIV, it may be noted that green gram 'kuzhakku' prepared in the improvised and steamer obtained maximum scores, followed by that cooked in the steam cooker, pressure cooker and 'idli' steamer. As shown in Appendix XI the differences for colour and doneness between the products cooked in the different cookers were not significant. However, with regard to consistency, there was a significant

difference between 'idli' steamer and steam cooker at one per cent level and between 'idli' steamer and the 'improvised' mud steamer at five per cent level showing that both the steam cooker and 'improvised' mud steamer were superior to the 'idli' steamer in consistency. In the case of taste, there was a significant difference at one per cent level between the product obtained in the 'improvised' mud steamer and those of the other three cookers showing that 'improvised' mud steamer was superior to all other cookers with regard to the taste of the green gram 'mashanka'.

e. Summary The mean scores and the analysis of mean differences for the palatability of bananas cooked using the selected cookers are presented in Table XV.

TABLE XV

MEAN SCORES FOR PALATABILITY OF BANANA COOKED USING THE FOUR COOKERS

Qualities	'IARI' steamer	Steam Pressure cooker	'Improved' cooker and steamer	Level of significance.
	Mean of replicates			
1. Colour	3.8	4.0	3.4	4.4	F= 2.7*
2. Odour	4.2	4.4	4.1	4.65	F= 0.023
3. Tenderness	4.2	4.7	4.0	4.4	F=3.65*
4. Denseness	4.1	4.7	4.2	4.4	F= 3.61*
5. Taste	4.06	3.9	3.5	4.2	F= 4.1*
Total	20.36	21.7	19.2	22.15	
Mean	4.07	4.34	3.84	4.43	

Mean Differences:

	I and S	I and P	I and H	S and P	S and H	H and P
Colour	−0.2	0.4	−0.6	0.6	−0.4	1.0**
P 0.05=0.8						
P 0.01=0.99						
Tenderness	−0.5*	0.2	−0.2	−0.70**	0.2	0.4
P 0.05=0.62						
P 0.01=0.82						
Denseness	−0.65*	−0.1	−0.2	0.55*	0.2	0.2
P 0.05=0.55						
P 0.01=0.41						
Taste	0.15*	0.55**	−0.15*	0.40**	−0.30**	0.70**
P 0.05=0.17						
P 0.01=0.1						

Table XV shows that bananas cooked in the 'improved' and steamer got the maximum scores followed by steam cooker and 'IARI' steamer. The pressure cooker obtained the minimum scores. The data given in Appendix XII shows that

there were no significant differences between the products of banana obtained from any of the cookers for colour and odour. Regarding tenderness and doneness, there were significant differences when the steam cooker was compared with the 'idli' steamer and pressure cooker. The steam cooker was significantly superior to the 'idli' steamer at five per cent level in tenderness. As for doneness, steam cooker was significantly superior to the 'idli' steamer at one per cent level and the pressure cooker at five per cent level. With regard to taste, there were significant differences between all the cookers. The results show that 'idli' steamer, 'improvised' and steamer and steam cooker are significantly superior to pressure cooker at one per cent level. The reason for obtaining poorer scores in the pressure cooker may be because the banana was overcooked due to eight minutes cooking at high temperature in 15 pounds pressure. Denton (1921)[38] states that even five to ten minutes at five pounds pressure will often overcook the fruit. As cooking time had been standardised at 8 minutes there was no possibility of reducing the cooking time only for the banana.

The results of the additional experiments conducted on palatability of foods cooked in pressure cooker in which the foods were cooked simultaneously at two different pressures namely 15 pounds and 10 pounds, as mentioned on page 50, are given in Appendix XIV. It was found that 'puttu' steamed at 10 pounds pressure obtained higher scores than

that steamed at 15 pounds pressure. Significant difference at one per cent level was found in doneness for 'puttu'. The scores obtained for green gram 'hunhunbu' and banana were identical.

5. Cost of fuel:

The total cost of fuel for cooking the standard breakfast using the different cookers is presented in Table XVI.

TABLE XVI

TOTAL COST OF FUEL FOR COOKING THE STANDARD BREAKFAST USING THE DIFFERENT COOKERS

Replicates.	Breakfast				Analysis of mean difference.
	'Idli' steamer	Steam cooker	Pressure cooker	'Improvised' pot and steamer.	
	Cost in Rs. Mean of replicates				
1.	3.80	3.68	2.61	3.88	$D_{0.01}$= 0.062 $D_{0.05}$= 0.037
2.	3.88	3.64	2.60	3.84	D_I and S= 0.08**
					D_I and P= −1.15**
3.	3.80	3.72	2.64	3.88	D_I and H= 0.7**
					D_S and P= −1.3**
4.	3.88	3.80	2.86	3.79	D_S and H= 0.18**
					D_P and H= 1.4**
Total	14.31	14.04	9.71	15.39	
Mean	3.577	3.66	2.47	3.847	

F = 346.1

It is seen from Table XVI that the cost of fuel is highest in the 'improvised' and steamer followed by steam cooker, 'Idli' steamer and pressure cooker. It is also observed that there was significant difference at one per cent

level between all the four cookers (Vide Appendix XIII). The percentage saving of fuel cost by using pressure cooker as compared to the other three cookers is calculated to be 50 per cent. The cost of fuel depends on the fuel consumption which is directly proportional to the time of cooking. Hence the differences in the cost of fuel are due to the differences in the time taken for cooking in the different cooker.

4. Time Taken for Cleaning:

The time taken for cleaning the four cookers after cooking is given in Table XVII.

TABLE XVII

TIME TAKEN BY CLEAN THE FOUR COOKERS AFTER COOKING

Replicates.	'Idli' Steamer	Steam Pressure cooker	'Improvised' cooker and steamer	Analysis of mean difference
	Time in seconds			
	Mean of Replicates			
1.	165	235	140	124	$D_{0.01}$=8.44 $D_{0.05}$=6.01
2.	178	241	137	148	D_I and S=95.5** D_I and P=92.0**
3.	162	234	130	139	D_I and [illegible] D_S and P=101.5**
4.	170	233	136	141	D_S and P=97.25** D_P and P=4.25
Total	670	948	542	559	
Mean	167.5	237	135.5	139.75	

F =570. P 0.01

The results given in Table XVII indicate that steam cooker took the maximum time for cleaning followed by the 'Idli' steamer, the 'improvised' and steamer and the pressure cooker taking least time. The results also indicate that there is no significant difference between the time taken for cleaning the 'improvised and steamer and pressure cooker. It was also observed that there were significant differences in the time taken for cleaning between the other cookers. The difference between the 'Idli' steamer and 'improvised' and steamer was found to be significant at five per cent level and those between the other cookers were significant at one per cent level (Vide

Appendix XIV) As the outer vessels of the steam cooker and 'idli' steamer are made of brass, they require a longer time for cleaning with the use of tamarind and ash.

V. SUMMARY AND CONCLUSIONS

A household survey of 50 families and a market survey of ten shops in Coimbatore City showed that 'idli' steamer, 'improvised' cooker, pressure cooker and steam cooker were the common types of cookers available in the market and widely used by the housewives. The 'idli' steamer, pressure cooker and steam cookers as well as one mud steamer improvised by the investigator were selected for this comparative study. The four selected cookers were compared by steaming items included in a breakfast namely, rice, 'puttu', green gram 'kushambu' and banana with regard to cooking time, palatability of foods cooked and money expenditure. The following conclusions were arrived at.

1. The pressure cooker took the minimum time, and the 'improvised' steamer the maximum time, with the 'idli' steamer and steam cooker falling in between for cooking the same breakfast. The percentage saving of time effected in using the pressure cooker was more than 100.

2. For palatability, maximum scores were obtained for 'puttu' steamed in the 'idli' steamer, and banana and green gram 'kushambu' steamed in the 'improvised' mud steamer. The foods steamed in the steam cooker obtained higher scores than those cooked in pressure cooker.

3. The cost of fuel was found to be the minimum in pressure cooker and maximum in 'improvised' mud steamer. The percentage saving of fuel cost by using pressure

cooker was found to be 50 per cent over that of the other three cookers. However, the initial cost of the pressure cooker was the highest among all the cookers and 'improvised' mud steamer the lowest.

4. Regarding the time taken for cleaning after cooking, the steam cooker was found to take the maximum time, next was 'idli' steamer in the order of duration and then 'improvised' mud steamer and pressure cooker respectively.

The findings of the study proved the superiority of pressure cooker with regard to economy of time and fuel, and of the 'improvised' mud steamer with regard to palatability of green gram 'hushhunbu' and banana, and of 'idli' steamer with regard to palatability of 'puttu'.

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A P P E N D I X

APPENDIX II.

Preparation: 'Puttu.'

Number of servings: 2

Ingredients.	Quantity.
Rice flour (Broiled) (gms)	170
Coconut scrapings (gms)	80
Sugar. (gms)	40
Salt (gms)	1
Water (ml.)	240

Methods

1. Take broiled rice flour in a stainless steel vessel.
2. Sprinkle salt water to the flour at intervals and mix well with the hand.
3. Repeat till the specified amount of water is over and the flour gains a satisfactory consistency.
4. Add sugar to the coconut scrapings.
5. Mix the coconut scrapings with the mixed flour.
6. Transfer the mixed flour to the cooker vessel for steaming.

APPENDIX III.

Preparation: Green gram 'Hashwada'.

Number of servings: 8

Ingredients	Quantity.
Green gram (gms)	100
Coconut scrapings (gms)	80
Water (for extraction of milk from the coconut scrapings) (ml)	390
Mustard (gms)	0.6
Onions (Chopped) (gms)	15
Chilly powder (gms)	1.5
Oil (gms)	8
Salt (gms)	6

Method:

1. Soak green gram in water for 4½ hours.
2. Extract coconut milk from the coconut scrapings.
3. Take coconut milk in the cooker vessel.
4. Heat oil in a frying pan.
5. Add mustard, then mustard bursts, add chopped onions.
6. When the onions turn brown add chilly powder.
7. Remove the pan immediately from the fire.
8. Add seasonings to coconut milk.
9. Transfer the soaked green gram to the vessel containing coconut milk. Stir well.
10. Place the vessel in the cooker for steaming.

APPENDIX IV.

Ingredients.	Quantity.
Ripe Banana	2

Method:

1. Cut each banana into pieces of 35 to 40 grams
2. Place the pieces in the cooker vessel for steaming.

APPENDIX V.

RESULTS OF THE TRIANGULAR TEST.

Judges.	Replicates.						Total.
	1	2	3	4	5	6	
1	/	/	/	/	/	/	0*
2	/	/	X	/	/	/	5*
3	/	X	/	/	/	/	5*
4	/	X	/	/	/	X	4
5	/	/	X	X	/	/	4
6	/	/	/	/	X	/	5*
7	X	/	/	/	/	X	4
8	/	/	/	X	/	/	5*
9	/	X	X	/	X	X	2
10	X	/	/	X	X	/	3

* Judges who were chosen for the panel.

APPENDIX IX

SCORE CARD FOR TASTE.

Date:

Judge: Kindly judge the given samples without discussion and tick against any one quality under each heading for each sample.

Quality	Description.	Samples. A	B	C	D
I Appearance:					
a. Flour separate:	1. Flour and coconut scrapings are separate				
	2. Flour and coconut scrapings slightly separate.				
	3. Flour and coconut stick together in ample lump				
	4. Flour stick together in big lumps.				
	5. The product is in a mass.				
b. Colour:	1. White				
	2. Slightly brown.				
	3. Brown.				
	4. Slightly discoloured.				
	5. Discoloured.				
II Doneness:	1. Well cooked.				
	2. Just cooked.				
	3. Over cooked.				
	4. Under cooked.				
	5. Uncooked.				
III. Odour:	1. Pleasant odour.				
	2. Odour of well cooked rice flour.				
	3. Odour of uncooked rice flour.				
	4. Slightly foreign odour.				
	5. Very unpleasant odour.				
IV. Taste:	1. Excellent.				
	2. Good.				
	3. Fair				
	4. Mixed.				
	5. Poor.				

Note: Any comments not included by the above may be given here.

Signature.

TABLE XXI.

SCORE CARD FOR GREEN GRAM "PREPARED".

Date:

Judge: Kindly judge the given samples without discussion and tick against any one quality under each heading for each sample.

Quality	Description.	Samples. A	B	C	D
I. Appearance: A. Colour:	1. Light brown.				
	2. Golden brown.				
	3. Slightly dark brown.				
	4. Dark brown.				
	5. Very dark brown.				
II. Consistency:	1. Fairly thick.				
	2. Thick				
	3. Very thick.				
	4. Thin.				
	5. Very thin.				
III. Odour:	1. Pleasant odour.				
	2. Odour of well cooked green gram.				
	3. Odour of uncooked green gram.				
	4. Slight foreign odour.				
	5. Very unpleasant odour.				
IV. Taste:	1. Excellent.				
	2. Good.				
	3. Fair.				
	4. Bland.				
	5. Poor.				
V. Consumer:	1. Well cooked.				
	2. Just cooked.				
	3. Overcooked.				
	4. Undercooked.				
	5. Uncooked.				

Note: Any comments not included by the above may be given here.

Signature.

APPENDIX VIII

SCORE CARD FOR BANANA.

Date:

Judge: Kindly judge the given sample without discussion and tick against any one quality under each heading for each sample.

Quality	Description.	Samples. A	B	C	D
I Appearance:					
Colour :	1. Greenish yellow.				
	2. Yellow.				
	3. Pale yellow.				
	4. Discoloured.				
	5. Darkened.				
II Doneness:	1. Well cooked.				
	2. Just cooked.				
	3. Over cooked.				
	4. Undercooked.				
	5. Uncooked.				
III. Tenderness:	1. Soft.				
	2. Fairly soft.				
	3. Very soft.				
	4. Hard.				
	5. Very hard.				
IV. Odour.	1. Odour of well steamed banana.				
	2. Pleasant odour.				
	3. Odour of uncooked banana.				
	4. Slightly foreign odour.				
	5. Very unpleasant odour.				
V. Taste:	1. Excellent.				
	2. Good.				
	3. Fair.				
	4. Bland.				
	5. Poor.				

Note: Any comments not included by the above may be given here.

Signature.

APPENDIX [illegible].

ANALYSIS OF VARIANCE FOR THE [illegible] TO COOK THE STANDARD [illegible] THE FOUR SELECTED COOKERS.

Source of variation.	Sum of squares	Degrees of freedom	Mean squares.
Between Cookers	1796.8	3	598.6 F= 33216
Within replicates	0.2	12	0.018

'F' at 0.05 = 3.49 'F' at 0.01 = 5.95 P < 0.01.

Tests for Differences by use of 't'.

Standard Deviation — within S. $D_{\cdot y}$ = $\sqrt{\text{Within variance.}}$

Standard Error of any two mean.

Defferences S.E. $S.E._{d}$ = $S.D._{\cdot y}\sqrt{\frac{1}{4}+\frac{1}{4}}$

Minimum difference required between any to mean for significance at five per cent level.

S. $E_{\cdot D}$	$t_{0.01}$	$t_{0.05}$	$D_{0.01}$	$D_{0.05}$
0.09	3.06	2.18	0.2787	0.1962

APPENDIX I.

ANALYSIS OF VARIANCE FOR THE MEAN SCORES OBTAINED FOR PALATABILITY OF "PUFFS" COOKED IN THE FOUR SELECTED OVENS.

Quality	Source of variation.	S.S.	d.f.	M.sq.	F.	S.E.$_D$	$D_{0.01}$	$D_{0.05}$
Flour Separateness	Between Ovens	9.84	3	3.21	3.86	0.30	0.81	0.61
	Within replicates	49.75	60	0.85				
Colour	Between Ovens	0.34	3	0.11	0.23	0.28	0.67	0.48
	Within replicates	28.28	60	0.47				
Denseness	Between Ovens	9.8	3	3.3	3.5	0.31	0.81	0.61
	Within replicates	56.28	60	0.95				
Odour	Between Ovens	2.45	3	0.82	1.3	0.25	0.67	0.50
	Within replicates	38	60	0.65				
Taste	Between Ovens	2.7	3	0.9	1.54	0.24	0.64	0.48
	Within replicates	35	60	0.58				

For 60 d.f. $t_{0.01} = 2.66$; $t_{0.05} = 2.00$

$D_{0.05}$ (Minimum mean difference required for significance at five per cent level) = S.E.$_D$ x $t_{0.05}$

$D_{0.01}$ (Minimum mean difference required for significance at one per cent level) = S.E.$_D$ x $t_{0.01}$

APPENDIX XI.

ANALYSIS OF VARIANCE FOR THE MEAN SCORES OBTAINED FOR PALATABILITY OF [illegible] SCORED BY FOUR SELECTED COOKERS.

Quality	Source of variation.	S.S.	d.f.	M.Sq.	F.	S.E$_D$	$E_{0.01}$	$E_{0.05}$
Colour	Between Cookers	1.45	3	0.48	0.36	0.56	0.97	0.72
	Within replicates	79.5	60	1.32				
Consistency	Between Cookers	21.7	3	7.2	6.86	0.32	0.53	0.64
	Within replicates	63	60	1.05				
Odour	Between Cookers	3.74	3	1.24	2.55	0.22	0.53	0.44
	Within replicates	29.25	60	0.49				
Denseness.	Between Cookers	1.7	3	0.56	0.56	0.26	0.59	0.51
	Within replicates	59	60	0.98				
Taste	Between Cookers	33.04	3	11.04	129	0.08	0.21	0.16
	Within replicates	4	60	0.08				

APPENDIX XXI.

ANALYSIS OF VARIANCE OF THE MEAN SCORES OBTAINED FOR PALATABILITY OF BANANA COOKED BY THE FOUR RECEIVED COOKERS.

Qualities.	Source of variation	S.S.	d.f.	m.sq.	F	S. E	$S_{0.01}$	$S_{0.05}$
Colour	Between Cookers	9.25	3	3.08	51.54	0.35	0.92	0.69
	Within replicates	3.7	60	0.06				
Odour	Between Cookers	1.1	3	0.36	0.83	0.35	0.97	0.65
	Within replicates	65	60	1.08				
Tenderness	Between Cookers	6.04	3	2.01	3.38	0.24	0.65	0.48
	Within replicates	34.75	60	0.58				
Juiciness	Between Cookers	4.7	3	1.56	3.62	0.21	0.55	0.42
	Within replicates	26	60	0.43				
Taste	Between Cookers	0.5	3	0.16	4	0.08	0.17	0.12
	Within replicates	2.5	60	0.04				

[redacted] XXII.

[redacted]

Qualities.	10 lbs. Pressure.	15 lbs. Pressure.
Flour superfineness	5.95	5.65
Colour	4.75	4.6
Denseness	4.45	5.25
Odour	4.55	4.2
Taste	4.15	3.6
Total	21.85	19.10
[redacted]	4.37	3.82

[redacted] XII.

[redacted] FOR THE TOTAL COST OF FUEL [redacted] IN THE [redacted] WORKS.

Source of variation.	Sum of squares.	Degrees of freedom	Mean squares.	
Between Coolers	56.84	3	18.61	F = 368.1
Within replicates	0.17	12	0.014	

'F' at 0.05 = 3.49 'F' at 0.01 = 5.95 P < 0.01

Tests for Difference by use of 't'

$D_{0.01}$	$D_{0.05}$
0.082	0.057

XV.

ANALYSIS OF VARIANCE FOR THE TIME TAKEN TO CLEAN [illegible] COOKERS AFTER COOKING.

Source of variation.	Sum of Squares.	Degree of freedom.	Mean Squares.	
Between cookers	26452.25	3	8817. 41	F= 579
Within replicates	182.75	12	15. 23	

'F' at 0.05 = 3.49 'F' at 0.01 = 5.95 P < 0.01

Tests for Differences by use of 't'

S. E.	$t_{0.01}$	$t_{0.05}$	$D_{0.01}$	$D_{0.05}$
2.76	3.06	2.18	6.35	8.51