Acceptability and Nutrient Content of Solar Cooked, Pressure Cooked and Boiled Pulses

By

R. SIVAKAMI

A THESIS SUBMITTED TO
THE AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN (DEEMED UNIVERSITY) COIMBATORE-641 043
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN FOOD SCIENCE AND NUTRITION

APRIL, 1994.

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CERTIFIED AS BONAFIDE RESEARCH WORK.

Signature of the Head of the Department	Signature of the Dean of the Faculty	Signature of the Guide

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INTRODUCTION

I INTRODUCTION

"ENERGY SAVED

IS

ENERGY PRODUCED"

Energy has become the most vital element for the development and survival of our society and as such in the absence of appropriate supply of energy, the aspirations of the human beings can't be met. The linkage between energy and prosperity is reflected in the life style of developed and developing countries. The annual percapita energy consumption in developed countries ranges from 5 to 11 kw where as in developing countries it is between 1 to 1.5 kw only, the global average being about 2 kw. This energy is used in the form of electrical energy, thermal energy, light, mechanical energy, chemical energy etc. (Sootha, 1993).

The energy sources are normally classified as renewable and non renewable. Renewable sources of energy are those energy which nature continuously renew on its own. They include direct energy from the sun namely the solar energy, wind energy, biomas energy, including fuel and charcoal, hydro power, ocean energy and animal wastes. Fossil fuels like petroleum products, natural gas etc, are non renewable sources.

The increasing demand for energy, oil prices, fast depletion of fossil fuels, rapid industrialization, unchecked deforestation and exponential population growth are among the factors which have inclaim to focus attention in renewable energy that are low cost and pollution free than non renewable energy which may be exhausted by the beginning of the next century, (Sushma et al, 1990 and Radhakrishnan, et al, 1991).

The human needs of this energy is increased by leaps and bounds. Energy from whichever sources it may be, is the prime requisite for growth and economic development. Disequilibrium created between demand and supply as a result of the growth of population which has led to serious energy crisis all over the world, (Devadas, 1993).

Therefore, the Indian planners and researchers are working on the renewable sources of energy such as solar energy, which is crucial to solve the present day energy crisis.

At the present time solar energy is more attractive than ever as an alternative energy resource which can provide heating, cooling and hot water at economically competitive costs and without environmental degradation. In order to reduce our nation's dependence on foreign energy resources while maintaining the vitality of our economy, it is imperative that we continue to develop all our energy options and utilize those which are most appropriate for each particular application. The decision as to what type of energy source should be utilized must, in each case, be made on the basis of economic, environmental and safety considerations. Because of the desirable environmental and safety aspects of solar energy, it should be utilized instead of nuclear or fossil alternatives even when its costs are slightly higher (Richard, 1977).

Solar energy is available abundantly in the world especially in tropical regions. It is the fuel of all earthly processor, animate and inanimate. Solar energy is a radiated energy from the sun into space and of which a minute fraction is intercepted by the earth (Brinkworth, 1972).

The energy provided by the sun is one lakh times of the total energy produced in the world Bartwal **et al**, (1987).

There are many applications of solar energy for farm and home. For farmer, solar drier, sprayer, solar tricycle are some of the application of solar energy. The solar water heater, and solar room heater, solar cookers are some of the applications of solar energy for domestic sector.

There are various problems arising out of the conventional source of energy which includes shortage of supplies, high prices, smoke and environmental hazards. The energy senario in India shows that cooking consumes a major portion of the energy. A significant contribution can be made to maintain the countries fuel resources by efficient utilization of available fuels (Bhat, 1986).

Fuel is fundamental necessity like food, when burnt in open chulas which is prevalent in villages produces smoke there by spoiling the cooking utensils, poluting environment, affecting the eyes of women and children who are all around chulas. Such problems can be over comed by the usage of solar cookers (Rai, 1984).

The production of fuel wood in the country is not only fluctuating from year to year but is showing on overall declining trend. It has been estimated that the existing supply of fuel wood constitutes about 95.4 per cent of the total requirement and given the present trend to continue the supply of fuel wood would fall short of demand by almost 15 per cent (Sushma et al, 1990).

The use of solar cooker can reduce deforestation and health hazards, while allowing more spare time to women and children for productive activities, education or vocational training (Dayal, 1985).

Solar cooker also helps to improve the physical health and well being of women by relieving them from the time consumption and strenuous activity of cooking in the dark and smoky kitchen. The drudgery removed is also enormous. Thus the introduction of solar cooker could play a major role not only reducing fossil fuel resources for cooking, but also in improving the working efficiency of the Indian home maker (Surayan, 1992 and Devadas, 1993).

The various types of solar cookers are box style solar cooker, multi reflector type solar cooker, concentrating type solar cooker, umbroiler type cooker, bamboo cane type solar cooker, and solar pressure cooker. Among these, the box type solar cookers have become quite known to the people and their use is increasing day by day (Rai, 1984).

Pulses have been occupying an important place in the diet of man ever since he stopped leading a nomadic life and started cultivation of crops. We use a variety of pulses like greengram, red gram, bengalgram, black gram, lentil and peas in our cookery, and although there are many regional differences in the pattern of pulse consumption, people in every region in India use some pulses in their diets. The people in the North, however, consume pulses in large amounts than people in South do.

Pulses are rich sources of protein in our diets, in a vegetarian diet or diet containing low amounts of animal foods they are an important source of protein. The major pulses which find an important place in our daily dietaries are bengalgram, black gram, green gram. Some of them are used as whole gram also. Others which are used as whole are cow pea, field beans; In amounts used, pulses and legumes do not contribute much to the total mineral intake. However being rich in B-vitamins they can contribute significantly to B-vitamin intake.

Pulses rich in lysine, hence they can supplement proteins of cereals and the quality of the protein from a mixture of cereals and pulses is superior to that of the either one (Gopalan et al., 1991).

In India we practise wet methods of cooking such as boiling, steaming, pressure cooking, and dry method of cooking at a high temperature such as frying, roasting, baking, as well as through newly developed microwave oven, and solar cookers.

Knowledge about various cooking process and its scientific principle is essential so as to enable an individual to select the right food and the suitable process that retain the nutrients and derive maximum from it to maintain our health.

Hence the present study was undertaken, taking into consideration of all afore said factors so as to identify the right cooking procedure and foods which can be processed, which could enable us to overcome one of the major global problems of energy crisis.

Thus the objectives of the present investigation are to find out the

1. acceptability of the various pulses prepared in solar cooking and other methods such as pressure cooking and boiling.

2. effects of selected cooking methods on the nutrient content of the pulses.

3. time taken for cooking the various pulses in the different cooking methods.

4. quantity of the water utilized for cooking and

5. cooked volume of the various pulses in the different cooking methods.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

The literature pertaining to the present study on "Acceptability and nutrient content of solar cooked, pressure cooked and boiled pulses" is reviewed under the following heads.

A. IMPORTANCE OF ENERGY

B. IMPORTANCE OF SOLAR ENERGY

C. SOLAR ENERGY IN COOKING AND DIFFERENT TYPES OF SOLAR COOKERS AND

D. EFFECTS OF COOKING METHODS ON THE NUTRIENT CONTENT OF FOODS

A. IMPORTANCE OF ENERGY

The term energy from the Greek word "energia" meaning capacity is reported to have been coined by Thomas Young [Dayal, 1985] Energy is simply a stored form of low entrophy the most valuable commodity on earth.

Bansan et al., (1990) pointed out that though the energy consumption in the developing countries accounts for a small part of the world total, it has been growing at a faster rate.

Gopal Sharma, [1992] has reported, primarily energy required for primitive man was in the form of food. He derived this by eating plants or animals which he hunted. Man has used energy at increasing rate for his survival and well being ever since he came on earth. Man has discovered fire, and his energy needs increased as he started to make use of natural elements like wood and other biomass to supply energy needs for cooking as well as for keeping himself warm.

Devadas, (1993) has pointed out that energy has no substitute, energy is the foundation on which human civilization rest, it is the basic natural resource, without which existence of human life is impossible. In fact, all the earthly activities are manifestations of energy in one form or another.

Rajagobal, (1993) pointed out that energy has many dimensions like electricity to engineers, heat in industrial furnaces are the motive force that powers machinery, to the economist it is a key ingredient in national prosperity and to the consumer it is the commodity he buys as gasoline and electricity.

According to Myles, (1981) energy is essential for all forms of life and his opinion is that energy has always been the key to man's greatest goals and to his dreams of a better world.

B. IMPORTANCE OF SOLAR ENERGY

Jose Goldemberg et al., (1988) pointed out that solar energy is high quality energy that is available in abundance. The total flow of solar energy through the earth natural system is some 10,000 times greater than the present flow of energy through man's machine.

According to Jain et al., (1989) there is an urgent need of a sustainable economy which must separate with lower levels of fossil, fuels, and probability without nuclear power as the oil resources are becoming finite and the unburnt fuel or the smoke emitted to the tune of six billion tonnes of carbondioxide leading to global environmental impairments. This emphasize the need for alternative source of energy.

Sootha, (1993) pointed out that the sun is a huge nuclear sector where hydrogen gas is continuously burning at high temperature and pressure and generating energy. A small fraction of the energy radiated by the sun into the space is also received on the surface of the earth in the form of radiant energy.

The maximum amount of energy available on the earth surface is in the range of 1 to 11 kw/m . This amount also does not remain same during the whole day. It depends upon the season of the year and the sky condition. Inspite of these variations the amount of solar energy received on the surface of our country is about 5×10^5 KWH/ year which is an enormous amount of energy. The solar radiation can be used to generate energy in different forms for our day to day life.

Stout, B.A. (1979) pointed out that the sun produces energy by converting mass into energy at a rate of millions of tons / second the total amount of energy striking the outer atmosphere of the earth in a year is 35000 times the energy used annually by man. The average intensity measured on a plane perpendicular to its path is 1.36 kilowatts / square meter when it reaches the earth's atmosphere.

We not only need energy today, but the ever increasing amount of energy that we will need tomorrow for our future generation that energy must be available at a price we can offer without damaging our planet. To maintain the standard of living we must find other ways to provide ourselves the energy we need.

Parikand, (1982) pointed out that in villages 95 per cent of energy consumed goes for cooking. Hence, the shortage of fuel for cooking is a serious matter and finding alternative source of fuel is an urgent need.

A recent survey of village in area of scanty rainfall, shows that 15 per cent of total working hours of the entire village population is spending in collecting firewood and this means that one person in a family of five to six is occupied in collecting firewood. In this situation, a solar cooker would be well accepted in villages and to certain extend can overcome the drudgery of the rural women.

C.SOLAR ENERGY IN COOKING AND DIFFERENT TYPES OF SOLAR COOKER

Fantagave, (1992) has pointed out that the solar cooker works on the solar energy and does not give smoke and soot spoils. It keeps free from nauseating smell and keeps environment clean thus conserving the precious energy source of the country and giving money. It is similar to what one use in the kitchen to cook food but not requiring any cooking gas or kerosene, nor any coal or any wood as a fuel.

Pushpa and Vijayaraghavan, (1993) pointed out that the utilization of solar cooker is not only a sanitary method of cooking but is also more ecologically balanced. The unique high solar radiation solar cookers are considered to be one of the solutions to the countries, energy problems and are being actively developed.

According to Haridas, (1983) solar cooker is a device which converts sunlight into heat energy and cooks the food. The principle is either to concentrate parallel sun rays to focus or absorb solar energy radiant on the surface of the earth in a flat plate collector and utilize it directly.

Thus heat generated from solar radiant energy can be used for cooking food, there are 6 types of solar cookers.

They are Simple Box type Solar Cooker, Concentrating type solar cooker, Multi Reflector type Solar Cooker, Umbroiler type Cooker, Bamboo cane type Solar Cooker and Solar Pressure Cooker.

1. Box type solar cooker

The solar rays penetrate through the glass covers and are absorbed by a blackened metal tray kept inside the solar box. The upper cover of the cooker has 2 glass sheets in parallel and thus heat loss through re-radiation is minimized from the blackened surface. Insulating materials like glass wool, paddy, saw dust or any other materials is filled in the space between blackened tray and outer cover of the box. This minimize the heat loss due to conduction. When this cooking is kept in the sun the blackened metal tray starts absorbing the sun's rays and the temperature inside the box starts raising.

2. Multi reflector type solar cooker

Multi reflector type solar cookers are ideal for baking purpose. The insulated cooker has glass windows to admit the solar radiation. For standing reflector of bright aluminium at the sides of oven reflect the light down through the window into the cooker temperature of 200^{o}C and above are obtained. A typical solar cooker consists of a well insulated semicylindrical bars made of sheet aluminium and wood. The box is mounted on a stand on wheel for the facility of shifting from one place to another.

The window of the cooker consists of two transparent glass sheets with a spacing of 2 cm. Two shell are made and the space between them is filled with fibre or glass wool or paddy husk insulation, the interior shell is painted black. A door of the same insulating material is also made for keeping and taking out food. A cradle type stand is also hung loosely from inside plate of the metal drum. The cooking pots are kept on these cradle which always keep themselves in horizontal position irrespective of the sun.

The maximum temperature is attained and all types of foods like cooking, roasting, baking and boiling are done from 25 to 75 minutes.

3. Concentrating type solar cooker

A variety of materials can be used for making parabolic reflectors. Taking into account the condition of use and aiming at a cooker of reasonable working life and adequate versatibility, researches have tended to favour a cooker with parabolic mirror of polished aluminium despite the apparent simplicity and low cost (Rs. 150/-) and these cookers considered costly and did not find wide acceptability in India. The cost of this type of cooker can be reduced by using aluminised mylar sheet instead of aluminium sheet. Such cooker has been made in U.S.A.

4. Umbroiler type cooker

It is an umbrella type of folding stove. It has an umbrella like reflector equipped with a grill. It could be placed easily in a box for transporting. It can be set up again in a minute or so. In bright sun light it can boil a quart of water in 20 minutes. The inner surface was silvered to concentrate the sun rays for skiers claimbing mountain.

5. Bamboo cane type solar cooker

It is low cost cooker made of bamboo cane with aluminium sheet as reflector on clear days in summer the temperature rises to 300 degree C and in winter 200^{0}C to 250^{0}C. Roasting, baking, boiling and frying can be done in 30 to 90 minutes during clear sky conditions.

6. Solar pressure cooker

Ibrahim A. et al., (1988) constructed a mini solar pressure cooker. It has an oven which is composed of a vapour-tight, spill-proof pot that is welded near the top to collector plates. Thus the pot top cover and the collector plate constitute the absorbing surface both the pot and the collector are made of aluminium. The plate and the pot are insulated on the bottom by glass wool and are placed in a wood box. The box has a single glass cover on the top to allow the transmission of solar radiation. Thus, the oven traps the heat using the greenhouse effect and well-insulated walls. Integral flat reflectors are used to reach a concentration ratio of about 3.5.

D. THE EFFECT OF COOKING METHODS ON THE NUTRIENT CONTENT OF FOODS

Stanton (1984) has defined cooking as a chemical process, the mixing of ingredients, the application and with drawal of heat, decision making, technical knowledge and manipulative skills.

A knowledge of various cooking processes and of the scientific principles which under lie them is desirable because it enables one to select for each food the process or processes which are likely to produce the most attractive, palatable and nutritive produce.

Brown, et al., (1989) has pointed out that in boiling which is a common method of moist heat cooking, water acts as a medium of heat transfer and because of its solvent matter, there is an inevitable loss of some mineral elements and vitamins and that the loss of latter being more important from a nutritional point of view. The losses are due to some factors namely solvent, action of water, volume of water used for cooking, period of cooking as well as the treatment the food receives before cooking.

Dowrey, (1972) and Brain et al., (1984) carried out series of studies and showed that the retention of vitamin C in some of the vegetables was found to be more in pressure cooking compared that of boiling. The vegetables were cauliflower, peas and spinach. They also found that the retention of the vitamin was more with less cooking time.

Chandrasehar U, (1993) in a study conducted on the nutritive value of different vegetables cooked in solar cooker and pressure cooker has found out that the percentage retention of nutrients, such as phosphorous, iron in the amaranth cooked in solar cooker was more than that of the boiling method. In the case of beans and carrot the calcium retention was more in solar cooker and the phosphorus retention of beans and cabbage was less in solar cooker. Iron retention was found to be less in the vegetable carrot when compared with the boiling method.

Angali et al., (1984) studied the acceptability and vitamin content of foods as affected by cooking in a sauce pan, pressure cooker and solar cooker. The foods selected were the common dishes like wheat porridge, green gram dhal, black gram dhal, bengalgram and potato curry. They reported that the final temperature of solar cooker ranged from 48.8 to 56.1^{o}C. and the cooking time was 45-160 minutes, depending on the material cooked percentage loss of thiamine was 2.5 to 28.1 per cent for solar cooked products, 12.5 to 31.7 per cent for pressure cooked recipes, and 25 to 41.5 per cent for boiled, percentages loss of riboflavin was 9.7 to 21.3 per cent for solar cooked, 12.9 to 30.0 pre cent for pressure cooked and 12.5 to 38.9 pre cent for boiled. The percentage loss of Vitamin C were 13.62 14.5 per cent for solar cooked products, 21.3 to 23 per cent for pressure cooker 32.2 to 32.7 per cent for boiled products.

They also reported that solar cooked items gave the best colour, flavour, texture, taste and overall acceptability.

The use of radiation to reduce the cooking time of legunces was investigated by Nene et al., (1975). This resulted in a reduction of cooking time ranging from 8-39 per cent due to increased hydration and cooking rates without affecting the texture.

Bangirwar and Srinivasan (1977) described a process to reduce the cooking time of peas. This involved steeping the peas in 0.25 per cent sodium bi-carbonate solution for 5 hours, pricking the peas for 10 minutes followed by pre cooking the peas for 4 minutes at 1-05 K Sc pressure. Then the peas are dried at 55-60^{0} C for 2-2 1/2 hours to reduce moisture content to 8 per cent in a tray drier. This process resulted in cooking time reduction 80 per cent and the peas reconstituted in 5-6 minutes.

Maturity plays a role in cookability of legumes. The results of investigations indicate that tender varieties of legumes cook faster than mature varieties.

Laxman singh **et al.**, (1977) studied three groups of maturity viz., early, medium, late varieties of pigeon peas with respect to their relative ease of cooking. The results indicated that a positive correlation for the cooking time.

There have been evidence supporting the theory that cooking time of legumes were reduced when they were steeped in water or in solutions containing levening salts,. prior to cooking. However, prolonged steeping in water was found to have detrimental effect on the cookability.

Narasimha and Desikachar, (1978) indicated that addition of chemicals to steep water or coating the legumes with chemicals were more effective than adding chemicals to cook water. An optimum salt concentration of 0.5 per cent in solution was found to yield acceptable product.

The time required for cooking is delayed by several factors such as moisture content, extended storage, and high temperature during storage all of which increases the cooking time (Deshpande **et al.**, 1986).

Starch and protein are the major seed components that absorb moisture during cooking. The size and shape of beans, surface area, seed thickness, rate of starch gelatinization and the nature and amounts of non starch constitutents that act as a physical barrier to the swelling of starch granuels may all influence the rate of water uptake during cooking of legumes Deshpande et al., (1984).

Earlier investigations indicated that the initial water uptake rates during soaking of legumes were dependent upon the density and the bulk density of seeds. After 24 hours soaking, however these relationship were lost. The final water uptake of a given variety was significantly correlated with its length/breadth. (L/B) ratio and weight, eliminating any influence due to volume.

Long slender beans with high L/B values observed more water as compared to small, round seed type. The seed thickness was linearly related to the optimal cooking time of beans. However, when optimally cooked, all the varieties showed a nearly constant water uptake of about 1.5gms per gram of beans. The optional cooking time of beans showed wide variation and were dependent upon seed hardness. Water uptake beans was also related to their surface area and was generally and related to the other physical characteristics of the seeds.

EXPERIMENTAL PROCEDURE

III. EXPERIMENTAL PROCEDURE

The experimental procedure of the present study on "Acceptability and Nutrient content of solar cooked, pressure cooked and boiled pulses consisted the following steps.

A. Selection of the foods.

B. Selection of the Cooking methods.

C. Preparation of the selected pulses.

D. Cooking of the selected pulses.

E. Conducting the Accepatability Trials.

F. Analysis of the Nutrients.

A. SELECTION OF THE FOODS

Among the different food groups, pulses are occupying an important place in the diets because they are rich in protein. Unlike cereal grains, pulses contains as much as 20-30 per cent protein. In the vegetarian diets and also in diets containing low amount of animal foods, the pulses are main sources of protein. Pricewise, the proteins of pulses are cheaper than proteins of animal origin/unit weight and it is for this reason pulses are sometimes referred to as poor man's meat. Hence the commonly used pulses were selected for this study. The common pulses used in higher frequency are bengalgram, cowpea, fieldbeans, greengran, hoursegram, peas and redgram. Hence these pulses were selected for the the present study.

B. SELECTION OF THE COOKING METHODS

All the foods consumed by man are subjected to cooking because it helps to preserve colour, get a variety of texture, enhance flavour and made the nutrients easily available, and it also increases the digestability and destroy harmful microorganism (Krishna Arora, 1987).

In India we practice wet method of cooking by boiling, steaming, pressure cooking, and dry method of cooking at high temperature like frying, roasting and baking etc.

India being a tropical country, solar energy is abundantly available, hence as a means of conserving energy, solar cooking was selected.

The other cooking methods selected for this study were pressure cooking and boiling. These methods were selected because they are the common methods used by all levels of people in India for cooking.

C. PRE PREPARATION OF THE SELECTED PULSES

All the pulses selected for this study were purchased in a whole lot and stored properly. The prepreparations such as cleaning, weighing, washing, soaking etc. were followed accurately at the same degree for all the three cooking methods. The Horse gram and Green gram were roasted before soaking and roasted weights were noted. All precautions were taken, so that there was no chance for variation due to pre preparation.

D. PREPARATION OF THE RECIPES

After soaking, the volume of water absorbed by the pulses and soaked weight of the pulses were noted. Then the pulses were cooked along with soaked water till it became tender. The volume of water absorbed for cooking and time taken for cooking were recorded. The cooked pulses were made as sundal by seasoning them with oil, mustard, green chillies and salt. After seasoning the pulses were weighed.

E. CONDUCTING ACCEPTABILITY TRIALS

Krishna, (1987) defines sensory evaluation as a science which uses human senses for measuring the appearance, Colour, flavour and taste.

The components like colour, texture, flavour, appearance and taste are very important as it gives stimulation to the appetite and delight in eating and leaves a feeling of satisfaction that makes for a better digestion. Unless this is not satisfied, the recipe or the food is said to be incomplete. Hence acceptability studies were conducted for the recipes prepared.

The acceptability studies included the following steps.

1. Formulation of the Score Card.

2. Selection of the Pannel members.

3. Conducting the Acceptability trials.

1. Formulation of the score card

The term scoring is frequently used erroneously where the score have not been shown to have such a defined relationship (Piggott, J.R., 1988).

Score cards were formulated and used for evaluating the recipes cooked by three methods. A five point scale score card was used for scoring the qualities like appearance, colour, texture, flavour and taste. (Appendix - I)

2. Selection of the panel members

A group of 10 members who were the students of post graudate course in the age of 22-23 years, physically fit, eager and willing to co-operate and who were ready to give time for judging the recipes were selected as the taste panel.

Little information about the study, the prepared recipes and a detailed scoring procedure was given to the panel members.

3. Conducting the acceptability trials

The prepared recipes were served in dishes of uniform size, shape and colour. A set of three digit random number was coded to the samples. Panel members were asked to taste the recipes at a right temperature. The time at which the panelists evaluated the samples was between 3 and 3.30 pm. The recipes were evaluated using the prepared score card. Acceptability trials were conducted thrice and the individual scores were recorded. (Plate II, III and IV)

F. Analysis of the nutrients

Knowledge about various cooking process and its scientific principle is essential so as to enable an individual to select the right food and the suitable process that retain the nutrients and derive maximum from it to maintain our health. Unless this is taken care of, the food becomes a waste to man because the nutritive value of cooked food play a vital part in contributing the required nourishment to the body (Brubacker et al., 1986 and Gopalan, 1989).

Raw pulses

The raw ingredients that are used for preparing the recipes were weighed accurately and they were blended and aliquots were taken for analysis of the various nutrients. Thus the nutrient content of the recipes before cooking was analysed thrice and each time values obtained are given in appendix - II to VII.

Cooked pulses

From the cooked pulses, three fourth portion was taken for acceptability trials, and the remaining one fourth portion was blended and aliquots were taken for the analysis of their nutrients vitamins like, thiamine, riboflovin, minerals like calcium, phosphorus and iron were analysed as per AOAC methods. The protein content was estimated using the Kjeltech Nitrogen Abalyzer. The analysis were carried out three times, and the values obtained are presented in Appendix - II to VII.

PLATE No:1 Solar Cooker

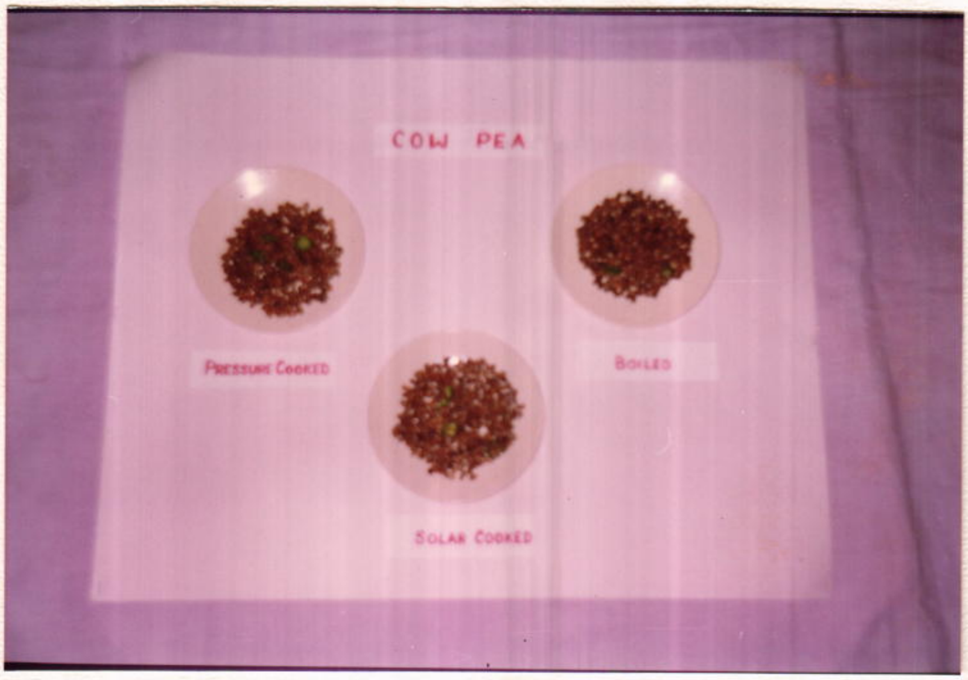


PLATE No:2 Solar Cooked, Pressure Cooked and Boiled Cowpea


FIELD BEANS
PRESSURE COOKED
BOILED
SOLAR COOKED


PEAS
PRESSURE COOKED
BOILED
SOLAR COOKED

RESULTS AND DISCUSSION

IV. RESULTS AND DISCUSSION

The results of this investigation on "Acceptability and nutrient content of solar cooked, pressure cooked, and boiled pulses" are presented and discussed under the following heads.

A. Acceptability of the pulses prepared by the selected cooking methods.

B. Nutrient content of the raw and cooked pulses.

C. Mean time taken for cooking the pulses by the selected cooking methods.

D. Quantity of water utilized for soaking and soaked weight of the pulses.

E. Quantity of water utilized for cooking and cooked weight of the pulses.

A. ACCEPTABILITY OF THE PULSES PREPARED BY THE SELECTED COOKING METHODS

Table I & II gives the mean total scores for different quality characteristics, overall acceptability, and the statistical analysis of various pulses prepared by three different modes of cooking.

TABLE - I

MEAN TOTAL SCORE OF PULSES COOKED BY THE SELECTED METHODS

S.No.	Pulses	Appearance Maximum Score (5)			Flavour Maximum Score (5)			Colour Maximum Score (5)			Texture Maximum Score (5)			Taste Maximum Score (5)			Overall Acceptability Maximum Score (25)		
		B	P	S	B	P	S	B	P	S	B	P	S	B	P	S	B	P	S
1.	Bengalgram	3.2	4.2	4.4	3.4	4.0	4.3	3.2	3.1	3.6	3.0	3.8	4.3	3.3	4.2	4.6	16.1	19.3	20.8
2.	Cowpea	2.7	4.3	4.5	3.9	4.2	4.4	3.3	4.1	4.2	2.1	4.6	4.5	3.2	4.0	4.5	15.2	21.2	22.1
3.	Field beans	3.5	4.3	4.5	4.1	4.3	4.5	3.5	4.3	4.5	3.0	4.2	4.2	3.0	4.2	4.1	17.3	21.2	21.1
4.	Greengram	3.3	4.1	4.4	3.4	4.2	4.4	2.8	3.0	3.4	3.7	3.8	3.9	3.3	4.7	4.3	16.5	19.2	20.4
5.	Horsegram	3.0	4.1	4.3	3.2	3.3	3.4	4.2	4.4	4.8	3.3	4.1	4.2	2.6	3.8	4.3	16.3	19.7	21.0
6.	Peas	3.7	4.0	4.4	3.1	4.1	4.2	4.1	4.1	4.5	2.7	4.0	4.1	3.7	4.1	4.2	17.3	20.3	21.4
7.	Redgram	3.0	4.3	4.3	3.2	4.1	4.2	4.0	4.2	4.5	2.3	3.1	3.5	3.1	4.2	4.2	16.4	19.9	20.5

Key = B -- Boiling P -- Pressure cooker S -- Solar Cooker

TABLE II

ANOVA TABLE FOR SELECTED PULSES

Source	Sum of squares	Degree of Freedom	Mean sum of Squares	F. Ratio	Table value at 1% level
Between Pulses	3.8	6	0.633	1.688	7.7183
Between Methods	82.4	2	41.2	109.8**	99.416
Error	4.5	12	0.375		

** Significant at 1% level

Anova --- Analysis of variance

It is observed that, the mean scores for colour, flavour, texture, appearance, taste and overall acceptability were highest for solar cooked pulses.

The statistical analysis also proves that there is a significant difference between the methods used for cooking pulses, and it is concluded that solar cooking method had a significant acceptability than other two methods.

Dhesi et al (1988) also reported that food items cooked in the solar cooker were appreciably good and were acceptable for their appearance, colour, texture, taste, flavour, shape and the average scores obtained from organleptic evaluation for the products cooked in solar cooker were not much different from the scores of the products cooked on gas. Similarly, findings by Sharma (1981) revealed that the recipes prepared in a solar cooker were found to be tasty and attractive.

The pressure cooked field beans had the maximum score for taste compared to solar cooking and boiling method.

In the preparation of red gram, solar cooking and pressure cooking had the highest score of 4.2 for taste.

B. NUTRIENT CONTENT OF THE RAW AND COOKED PULSES

The raw and cooked pulses were analysed for their nutrient content and the results are discussed under the following heads.

1. PROTEIN

The protein content (in g/100g) of the raw and cooked pulses was analysed and it is presented in Table - III and figure - 1.

TABLE - III

PROTEIN CONTENT (in g/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw	Boiled		Pressure Cooked		Solar Cooked	
			Cooked	Percent loss	Cooked	Percent loss	Cooked	Percent loss
1.	Bengalgram	12.2	11.0	9.8	11.8	3.2	11.9	2.4
2.	Cowpea	17.0	14.6	14.1	15.4	9.4	16.1	5.3
3.	Fieldbeans	17.5	15.2	13.1	17.0	2.8	17.0	2.8
4.	Greengram	17.0	15.0	11.7	16.2	4.7	16.6	2.3
5.	Horsegram	16.2	15.0	7.4	15.5	4.3	15.7	3.0
6.	Peas	15.0	13.3	11.3	14.4	4.0	14.6	2.6
7.	Redgram	22.5	20.4	9.3	21.2	5.7	21.5	4.4

Pulses cooked by boiling method showed maximum loss in the protein content. Among the various pulses cooked by boiling method, cowpea showed the maximum cooking loss of about 14.6 per cent while the minimum loss was found in horse gram 7.4 per cent.

The loss of the protein content in pressure cooking and solarcooking methods was found to be maximum in cowpea ie 9.4, 5.3 per cent respectively. But the minimum loss in pressure cooking and solar cooking was found in bengalgram, greengram ie 3.2 and 2.3 per cent respectively.

From the above results it is clear that of all the pulses, cowpea had the maximum cooking loss of 14.1 per cent in protein by boiling method, and the minimum loss of 2.3 per cent in greengram by solar cooking method.

The above result also proved that, there was a minimum loss of protein in all the selected pulses cooked by solar cooking (2.3 to 5.3 per cent) when compared to pressure cooking (3.2 to 9.4 per cent), and boiling (7.4 to 14.1 per cent). Similar observation were made by Devadas and Venmathi (1992), who reported that the loss of protein in solar cooking was less than by other cooking methods.

However the protein content of all the selected pulses were reduced on cooking irrespective of the methods. According to swaminathan (1979) severe heat processing has been reported to affect adversely the nutritive value of proteins.

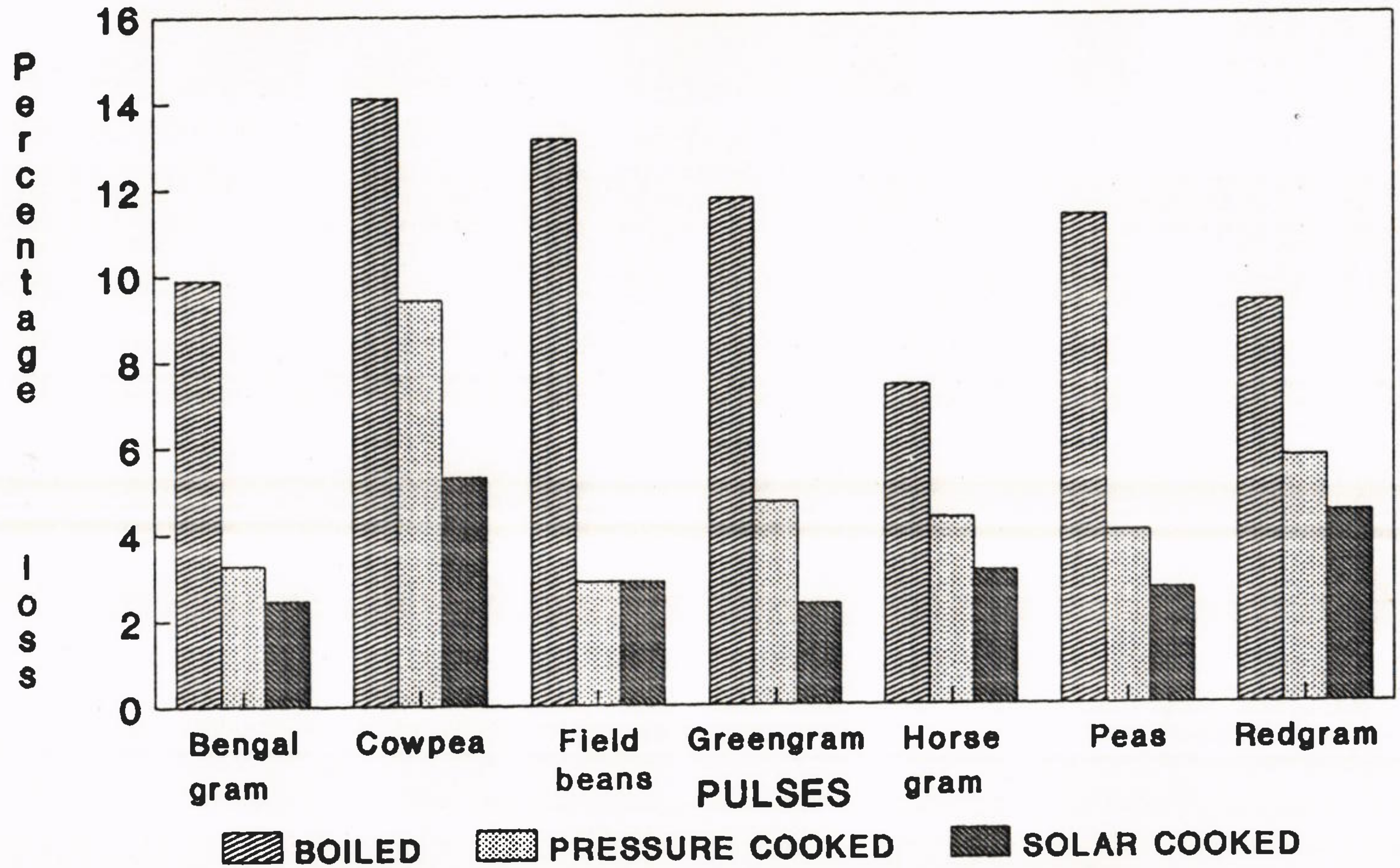
2. THIAMINE

Table IV and figure 2 represents the thiamine content(in mg/100g) of the selected pulses before and after cooking by the selected methods.

TABLE - IV

THIAMINE CONTENT (in mg/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw	Boiled		Pressure Cooked		Solar Cooked	
			Cooked	Percent loss	Cooked	Percent loss	Cooked	Percent loss
1.	Bengalgram	0.29	0.20	31.0	0.21	27.5	0.22	24.1
2.	Cowpea	0.41	0.29	29.2	0.34	17.0	0.36	12.2
3.	Fieldbeans	0.41	0.30	26.8	0.33	19.5	0.36	12.2
4.	Greengram	0.33	0.23	30.3	0.26	21.2	0.28	15.1
5.	Horsegram	0.33	0.24	27.2	0.28	15.1	0.29	12.1
6.	Peas	0.31	0.23	25.8	0.26	16.1	0.27	12.9
7.	Redgram	0.22	0.16	27.2	0.17	22.7	0.16	13.6



PERCENTAGE LOSS OF PROTEIN

Figure 1

It was observed that a maximum loss of thiamine in bengalgram cooked by all the three cooking methods i.e., 31.0 per cent by boiling, 27.5 per cent by pressure cooking, and 24.1 by solar cooking, while the minimum cooking loss was found in peas (25.8 percent) by boiling method, whereas by pressure cooking and solar cooking horsegram showed minimum loss of 15.1, 12.1 percent respectively.

In all the pulses cooked by selected cooking method, bengalgram showed maximum loss of 31.0 per cent by boiling method and horsegram showed a minimum of 12.1 per cent by solar cooking method.

The percentage loss of thiamine in all the selected pulses was lesser in solar cooking (12.1 to 24.1 per cent) when compared to pressure cooking (15.1 to 27.5 per cent) and boiling (25.8 to 31.0 per cent).

The results obtained was similar to that of Anjali et al (1984). They reported that the pulses (green gram, bengal gram and black gram dhal) cooked in solar cooker had minimum cooking loss (12.5 to 28.1 per cent) followed by pressure cooking (12.5 to 31.7 per cent) and boiling (25 to 41.5 per cent).

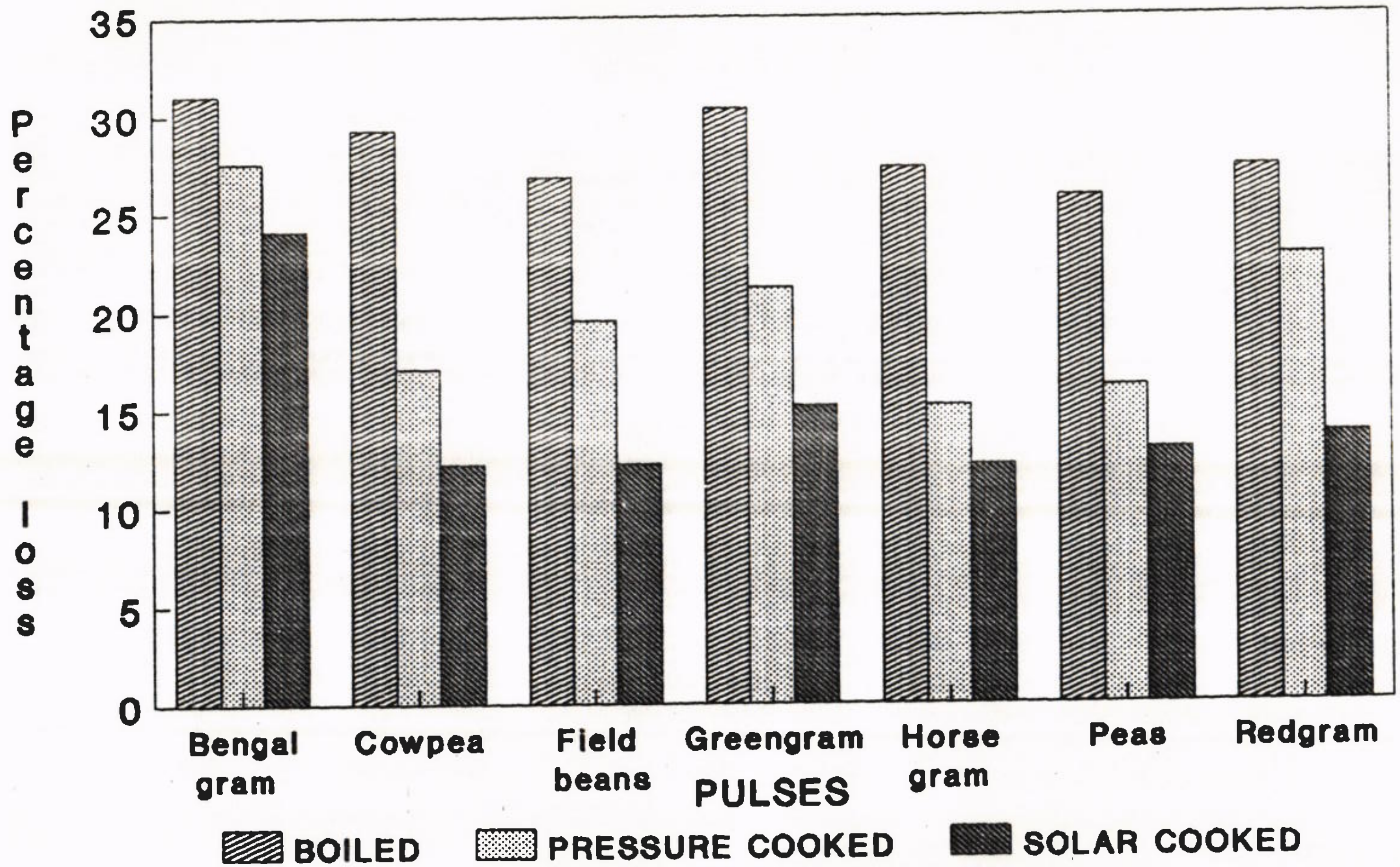
3. RIBOFLAVIN

Table V and figure 3 represents the riboflavin content (in mg/100g) of the pulses before and after cooking by the selected methods.

TABLE - V

RIBOFLAVIN CONTENT (in mg/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw	Boiled Cooked	Boiled Percent loss	Pressure Cooked Cooked	Pressure Cooked Percent loss	Solar Cooked Cooked	Solar Cooked Percent loss
1.	Bengalgram	0.13	0.10	23.0	0.11	15.3	0.12	7.7
2.	Cowpea	0.15	0.11	26.6	0.13	13.3	0.14	6.6
3.	Fieldbeans	0.09	0.06	33.3	0.07	22.2	0.08	11.1
4.	Greengram	0.20	0.16	20.0	0.18	10.0	0.19	5.0
5.	Horsegram	0.14	0.11	21.4	0.12	14.2	0.13	7.1
6.	Peas	0.09	0.06	33.3	0.07	32.2	0.08	11.1
7.	Redgram	0.18	0.14	22.2	0.16	11.1	0.17	5.5



PERCENTAGE LOSS OF THIAMINE

Figure 2

Pulses cooked by the boiling method recorded maximum losses in riboflavin content. Among them peas and fieldpeans recorded maximum loss of 33.3 per cent where as the minimum loss was found in green gram 20.0 per cent. This might be due to cooking at a high temperature for a longer time.

The loss of riboflavin in pressure cooking was found to be maximum in peas, field beans 22.2 per cent and the minimum was recorded in green gram 10.0 per cent.

In solar cooking, also peas and field beans and peas recorded maximum of 11.1 per cent, and the minimum of 5.0 per cent loss was recorded in green gram.

The above results indicate that among all the pulses cooked by three cooking methods, green gram recorded the minimum percentage of loss, whereas peas and field beans showed the maximum percentage of cooking loss.

There was a minimum loss of riboflavin in all the selected pulses by solar cooking (5.0 to 11.1 per cent) when compared to pressure cooking (10.0 to 22.2 per cent) and boiling (20.0 to 33.3 per cent).

The results obtained are similar to that of result observed by Anjali et al (1984). They reported hat the pulses cooked in solar cooker had minimum cooking loss (12.5 to 28.1 per cent) followed by pressure cooking (12.9 to 30.0 per cent) and boiling 12.5 to 38.9 per cent).

However the riboflaving content of all the slected pulses were reduced on cooking irrespective of the cooking methods followed.

4. CALCIUM

Table VI and figure 4 represents the calcium content (in mg/100 mg) of the selected pulses prepared by the selected cooking methods.

TABLE - VI

CALCIUM CONTENT (in mg/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw	Boiled		Pressure Cooked		Solar Cooked	
			Cooked	Percent loss	Cooked	Percent loss	Cooked	Percent loss
1.	Bengalgram	136	115.0	15.4	127.0	6.6	132.0	2.9
2.	Cowpea	60	47.0	21.5	55.0	8.3	56.0	6.6
3.	Fieldbeans	52.0	44.0	15.1	47.0	9.6	49.0	5.7
4.	Greengram	108.0	96.0	11.1	100.0	7.4	102.0	5.5
5.	Horsegram	208.0	181.0	12.9	199.0	4.3	203.0	2.4
6.	Peas	60.0	45.0	25.0	53.0	11.6	58.0	3.3
7.	Redgram	180.0	163.0	9.4	174.0	3.3	176.0	2.2

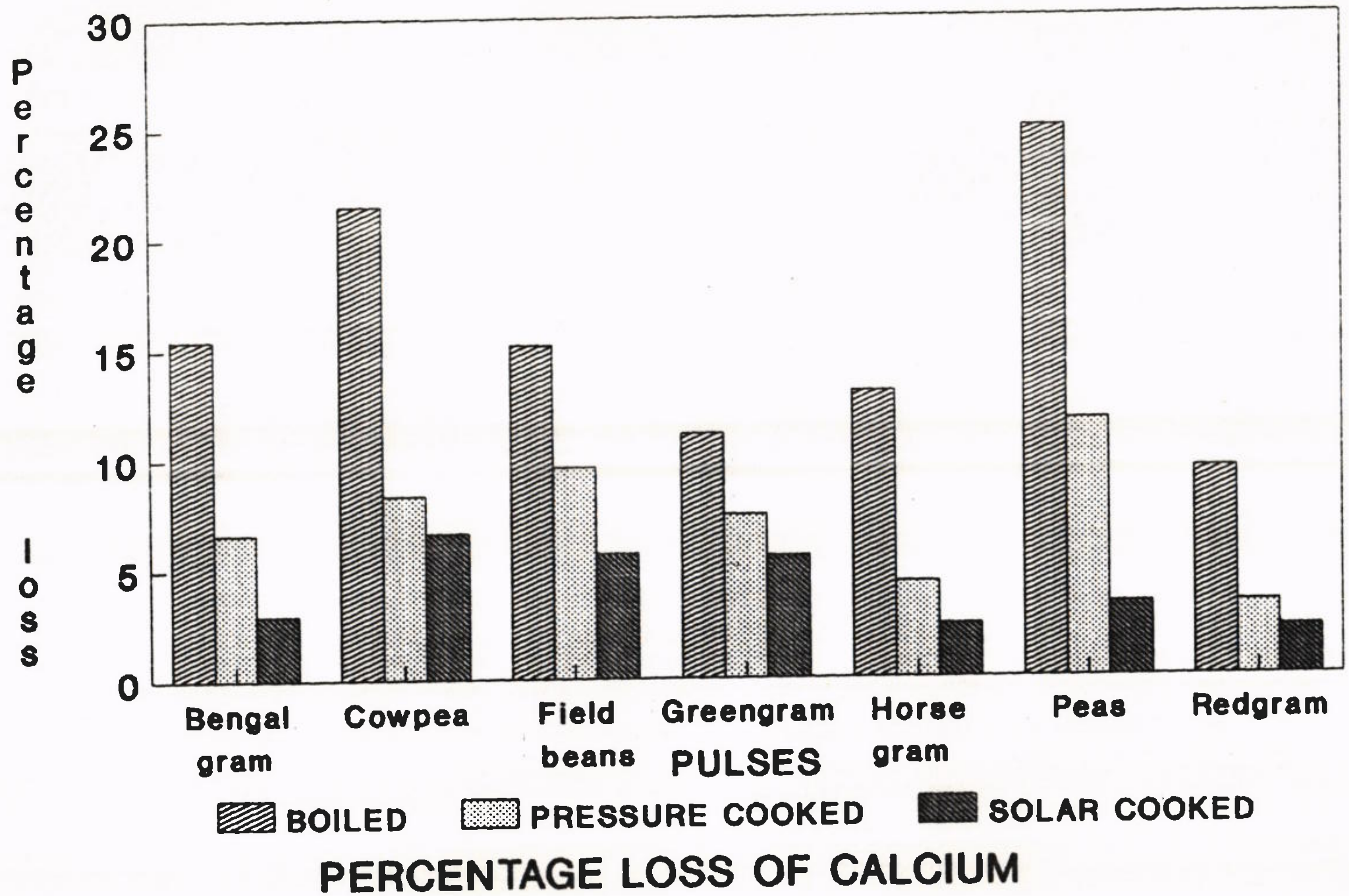

Percentage loss
30
25
20
15
10
5
0
Bengal gram
Cowpea
Field beans
Greengram
Horse gram
Peas
Redgram
PULSES
BOILED
PRESSURE COOKED
SOLAR COOKED
PERCENTAGE LOSS OF CALCIUM

Figure 4

Peas had the maximum calcium loss of 25.0 per cent, the red gram had the minimum loss of 9.4 per cent in the boiling method.

Pressure cooking also showed maximum cooking loss of calcium in peas 11.6 per cent, and the minimum of 3.3 per cent in red gram.

Solar cooked pulses showed maximum and minimum loss of calcium in cowpea 6.6 per cent, red gram 2.2 per cent respectively.

Thus it is indicated that the percentage loss of calcium among the selected pulses by the three cooking methods red gram had the minimum cooking loss and peas had maximum in boiling and pressure cooking method. But the cowpea showed maximum cooking loss in solar cooking.

The percentage loss of calcium in all the selected pulses was minimum in solar cooking (2.2 to 6.6 per cent) when compared to that of pressure cooking (3.3 to 11.1 per cent and boiling method (9.4 to 25.0 per cent).

Similar observation was made by the studies at Agriculture Research station lam, Anderapradesh, (1981) who had reported that various process applied on redgram showed loss of calcium.

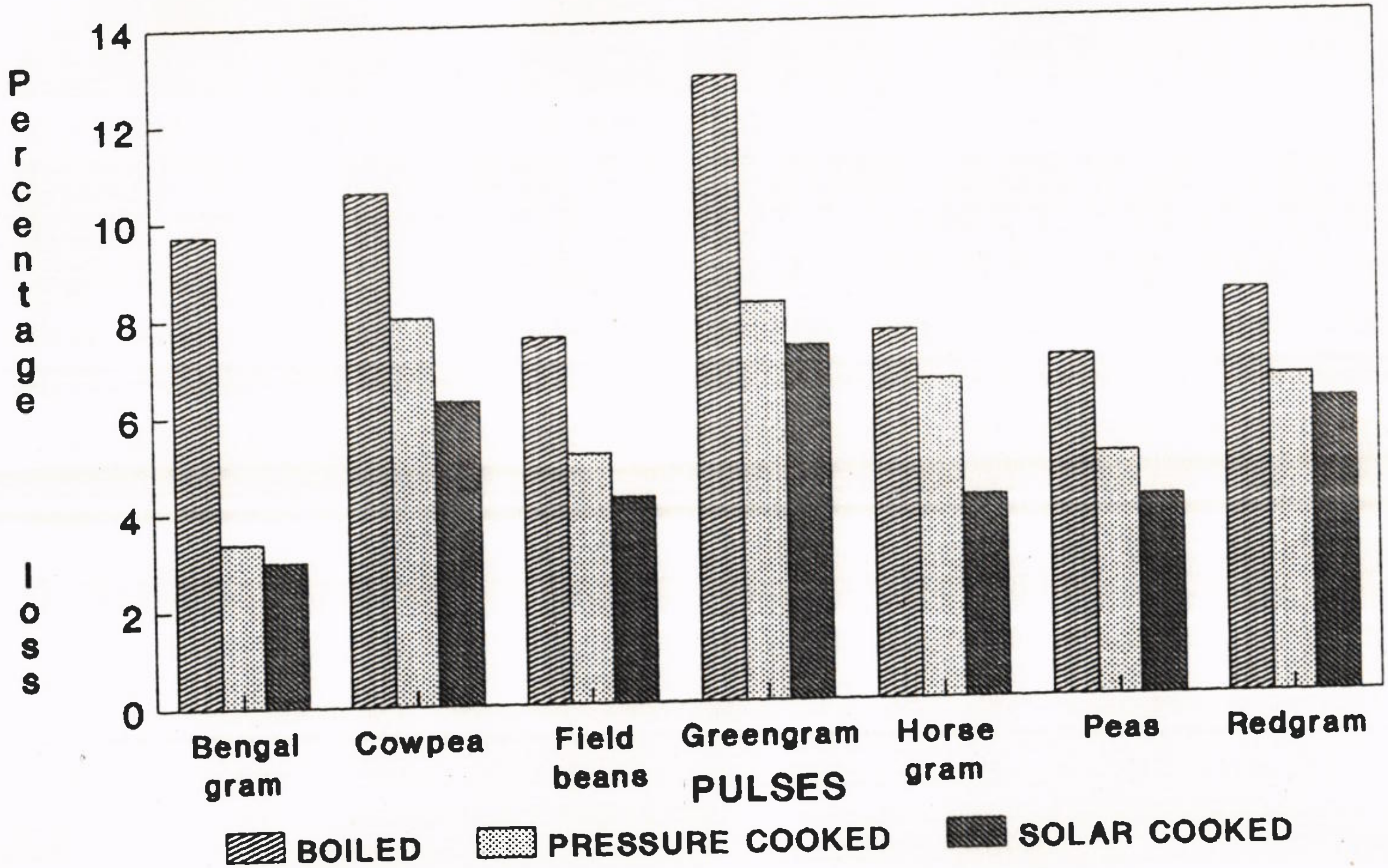
5. PHOSPHORUS

Table VII and figure 5 represents the phosphorus content (in mg/100mg) of the selected pulses prepared by three cooking methods.

TABLE - VII

PHOSPHORUS CONTENT (in mg/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw	Boiled Cooked	Boiled Percent loss	Pressure Cooked Cooked	Pressure Cooked Percent loss	Solar Cooked Cooked	Solar Cooked Percent loss
1.	Bengalgram	224	202.2	9.7	216.4	3.4	217.4	2.9
2.	Cowpea	350	313.0	10.5	322.0	8.0	328.0	6.3
3.	Fieldbeans	304.0	281.0	7.5	288.4	5.1	291.1	4.2
4.	Greengram	256.0	223.2	12.8	235.0	8.2	237.3	7.3
5.	Horsegram	224.0	207.0	7.5	209.3	6.5	214.7	4.1
6.	Peas	240.0	223.2	7.0	228.0	5.0	230.4	4.1
7.	Redgram	288.0	264.1	8.3	269.2	6.5	270.6	6.0



PERCENTAGE LOSS OF PHOSPHORUS

Figure 5

In all the three cooking methods maximum loss was found in green gram by boiling (12.8 per cent), pressure cooking (8.2 per cent) and solar cooking (7.3 per cent), and the minimum loss was found in peas by boiling, bengal gram by pressure cooking i.e (7.0 to 3.4 per cent) respectively, field beans 2.9 per cent by solar cooking.

Between the three selected cooking methods solar cooking had the minimum loss of phosphorus (2.9 to 7.3 per cent) followed by pressure cooking, 3.4 to 8.2 per cent) and boiling (7.0 to 12.8 per cent).

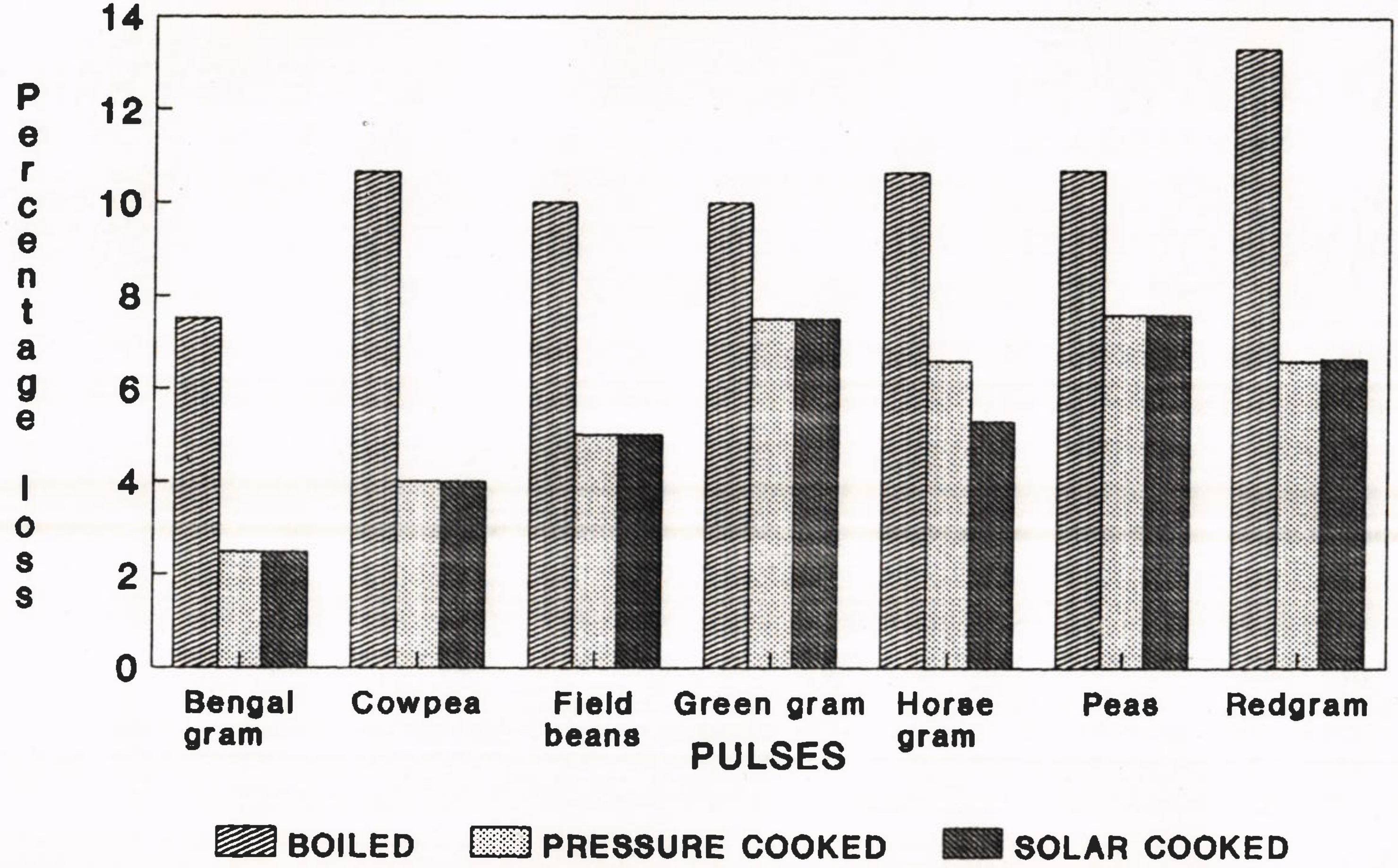
IRON

Table VIII and figure 6 represents the iron content (in mg/100g) of the pulses prepared by selected cooking methods.

TABLE - VIII

IRON CONTENT (in mg/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw	Boiled Cooked	Boiled Percent loss	Pressure Cooked Cooked	Pressure Cooked Percent loss	Solar Cooked Cooked	Solar Cooked Percent loss
1.	Bengalgram	4.0	3.7	7.5	3.9	2.5	3.9	2.5
2.	Cowpea	7.5	6.7	10.6	7.2	4.0	7.2	4.0
3.	Fieldbeans	2.0	1.8	10.0	1.9	5.0	1.9	5.0
4.	Greengram	4.0	3.6	10.0	3.7	7.5	3.7	7.5
5.	Horsegram	7.5	6.7	10.6	7.0	6.6	7.1	5.3
6.	Peas	6.5	5.8	10.7	6.0	7.6	6.0	7.6
7.	Redgram	1.5	1.8	13.3	1.4	6.6	1.4	6.6



PERCENTAGE LOSS OF IRON

Figure 6

Pulses cooked by boiling method showed maximum losses in iron content. Among the various pulses, red gram showed the maximum loss of 13.3 per cent by boiling method and minimum loss was found in bengal gram 7.5 per cent.

In the pressure cooking and solar cooking the maximum loss of 7.6 per cent was noted in the peas while the minimum loss was found in bengal gram 2.5 per cent.

From the above result it is clear that the bengal gram had the minimum cooking loss in all the three cooking methods. By boiling method showed maximum iron loss in red gram where as pressure cooking and solar cooking showed maximum loss in peas.

The percentage loss of iron in all the selected pulses was less in solar cooking and pressure cooking (2.5 to 7.6 per cent) followed by boiling method (7.5 to 13.3 per cent).

However there was not much difference between solar cooking and pressure cooking method with regard to loss of iron content.

C. MEAN TIME TAKEN FOR COOKING THE PULSES BY THE SELECTED COOKING METHODS

Table IX summarises the mean time taken to cook the pulses by the selected cooking methods.

TABLE IX

MEAN TIME TAKEN TO COOK THE PULSES BY THE SELECTED COOKING METHODS

S.No.	Pulses	Mean time taken for cooking (in minutes) Boiling	Pressure Cooking	Solar Cooking
1.	Bengalgram	45.0	15	90
2.	Cowpea	44.0	15	90
3.	Greengram	41.0	15	90
4.	Fieldbeans	42.5	15	90
5.	Horsegram	43.0	15	90
6.	Peas	43.0	15	90
7.	Redgram	45.0	15	90

The pressure cooking method consumed veryless time for cooking (15 minutes) followed by boiling and solar cooking (41 to 45, 90 minutes).

Duration of time for cooking was lesser by pressure cooking when compared to that of boiling and solar cooking. This is due to the fact that in solar cooker longer time is taken to attain the cooking temperature.

Seeds of legumes of the same species have different cooking time. Siegal and fawecett (1981) showed for 100 cowpea lines that cooking time ranged from 35 to 90 minutes and water uptake from 98 to 170 per cent. Reasons for these variations are not know Muller (1981) investigated cooking time and concluded that the presence of seed coat greatly increased the time of cooking for a number of different legumes, but the other two factors involved were the thickness and composition of the seed coat as well as the composition of the cotyledonary cell walls.

D. QUANTITY OF WATER ABSORBED WHILE SOAKING AND SOAKED WEIGHT OF THE PULSES

Table X represents the average volume of water absorbed while soaking and soaked weight of the pulses.

TABLE X

AVERAGE VOLUME OF WATER UTILISED WHILE SOAKING AND SOAKED WEIGHT OF THE PULSES

S.No.	Pulses	Raw Weight (gms)	Volume of Water Absorbed (ml)	Soaked Weight of the pulses (gms)
1.	Bengalgram	25	23.3	42.5
2.	Cowpea	25	30.0	51.0
3.	Fieldbeans	25	25.0	47.3
4.	Greengram	25	23.0	42.5
5.	Horsegram	25	22.0	45.6
6.	Peas	25	25.0	50.1
7.	Redgram	25	23.0	42.5

The quantity of water absorbed for soaking was more in cowpea (30.0 ml) and was less in peas (22.0 ml).

Deshpannde et al (1988) showed that the initial water uptake rates during soaking of legumes were dependent upon the density and bulk density of seeds. After 24 hours soaking how ever these relationship were lost.

The soaked weight of the different pulses vary from 40 to 51 gms. Cowpea absorbed the highest amount of water and gives maximum weight of 51.0 gms. From the above result it is clear that those obsorb higher amount of water gives higher soaked weight.

E. QUANTITY OF WATER UTILIZED FOR COOKING AND COOKED WEIGHT OF THE PULSES

Table XI represents the average volume of water absorbed while cooking and cooked weight of the pulses.

TABLE XI

AVERAGE VOLUME OF WATER UTILISED WHILE COOKING AND COOKED WEIGHT OF THE PULSES

S.No.	Pulses	Raw Weight (gms)	Volume of Water absorbed while cooking (ml)			Cooked Weight of the pulses (gms)		
			B	P	S	B	P	S
1.	Bengalgram	25	282.0	26.0	34.0	45.3	50.0	48.1
2.	Cowpea	25	290.0	29.5	38.2	52.0	54.8	53.0
3.	Fieldbeans	25	267.0	25.5	36.0	51.6	55.0	54.0
4.	Greengram	25	255.0	27.0	36.0	45.1	50.1	48.1
5.	Horsegram	25	256.0	20.0	26.5	47.1	49.1	48.1
6.	Peas	25	282.0	25.0	28.0	51.6	54.8	54.0
7.	Redgram	25	297.0	26.5	29.0	43.6	48.0	46.3

The quantity of water utilised for cooking was more in the boiling method followed by solar cooking and pressure cooking. This is due to fact that in the boiling method the evaporation of water is higher than the other two methods.

The average cooked volume of the pulses in the boiling method was found to be less when compared to that of pressure cooking and solar cooking. The cook weight was found to be more in pressure cooking method followed by solar cooking and boiling methods.

Inspite of greater amount of water utilised in boiling method the cooked weight was lesser.

SUMMARY AND CONCLUSION

V. SUMMARY AND CONCLUSION

Disequilibrium created between the demand and supply due to population growth has lead to serious energy crisis. One of the renewable source of energy is solar energy which is abundantly present in the tropical region ,has been identified as alternative source of energy to solve the daily energy problem.

Hence the present investigation was undertaken to findout the effect of solar cooking on nutrient content and acceptability of the foods. The study was carried out with the help of box type solar cookers which is simple to use and easy to manufacture and can be used for longer period. Seven commonly used pulses were selected and were cooked by the methods of boiling, pressure cooking and solar cooking. The volume of water absorbed while soaking and cooking, soaked, cooked weight of the pulses and the time taken for cooking were abserved. The major findings of the present study are summarised as follows:

The solar cooked pulses had the highest acceptability when compared with other two cooking methods. Among solar cooked pulses cowpea had the highest acceptability.

Among all the pulses cooked by selected cooking methods Cowpea showed the maximum protein loss of 14.1 per cent by boiling method and the minimum loss of 2.3 per cent in greengram by solar cooking method.

The per centage of protein losses in all the selected pulses cooked by solar cooking was less (2.3 to 5.3 per cent) when compared to pressure cooking (3.2 to 9.4 per cent) and boiling (7.4 to 14.1 per cent).

In all the pulses cooked by selected cooking methods bengalgram showed maximum thiamine loss of 31.0 per cent by boiling method, while horesegram showed minimum of 12.1 per cent by solar cooking method.

The losses of thiamine in all the selected pulses was less in solar cooking (12.1 to 24.1 per cent) followed by pressure cooking (15.1 to 27.5 per cent) and boiling (26 to 31.0 per cent).

Among various pulses cooked, the maximum of 33.3 per cent loss of riboflavin was found in peas by boiling method, while the minimum loss of 5.0 per cent was found in greengram by solar cooking method.

There was a minimum loss of riboflavin in all the selected pulses cooked by solar cooking (5.0 to 11.1 per cent) when compared to pressure cooking (10.0 to 22.2 per cent) and boiling (20.0 to 33.3 per cent).

In the case of percentage loss of calcium content peas showed maximum loss of 25 per cent by boiling method and redgram showed minimum loss of 2.2 per cent by solar cooking method.

The per centages loss of calcium was found to be less in solar cooking (2.2 to 6.6 per cent) followd by pressure cooking (3.3 to 11.6 per cent) and boiling (9.4 to 25.0 per cent).

Among all the pulses greengram showed maximum phosphorus loss of 12.8 per cent by boiling method and bengalgram showed minimum of 2.9 per cent by solar cooking method.

The losses of phosphorus in all the selected pulses was minimum in solar cooking (2.9 to 7.4 per cent) followed by pressure cooking (3.3 to 8.0 per cent) and boiling (7.0 to 12.8 per cent).

In all the pulses cooked by selected cooking methods redgram showed maximum iron loss of 13.3 per cent by boiling method while bengalgram showed minimum of 2.5 per cent by pressure cooking and solar cooking.

The percentage loss of iron was found to be same in both solar cooking and pressure cooking (2.5 to 7.6 per cent) than the boiling method (7.5 to 13.3 per cent). No difference was observed in the iron loss in pulses prepared by solar cooking and pressure cooking.

Since the losses of vitamins like thiamine and riboflavin was more in pressure cooking and boiling method. Hence solar cooking can be used to cook foods rich in vitamins like thiamine and riboflavin. In the case of minerals like iron and phosphorus, the cooking loss was almost same in pressure cooking and solar cooking but the calcium loss was maximum in pressure cooking and boiling method. Hence foods rich in calcium can be cooked by using solar cooking.

The pressure cooking method consumed very less time for cooking (15 minutes) followed by boiling (41 to 45 minutes) and solar cooking (90 minutes) Duration of time for cooking was lesser by pressure cooking when compared to that of boiling and solar cookinng. It is due to the fact that in solar cooker longer time is taken to attain the cooking temperature.

The quantity of water absorbed for soaking was more in cowpea (30 ml) and was less in peas (22 ml). The soaked weight of the different pulses vary from 40 to 51gms.

Cowpea absorbed the highest amount of water and gives miximum weight of 51.0 gms. Hence, the result indicated that those absorb higher amount of water gives higher soaked weight.

The average cooked volume of the pulses in the boiling method was found to be less when compared to that of pressure cooking and solar cooking. The cooked weight was found to be more in pressure cooking method followed by solar cooking and boiling method.

From this study it is concluded that the solar cookers are considered to be one of the solutions to the energy problems. Various problems like high prices, smoke and environmental hazards, which are due to the use of conventional source of energy and fuel solar cooker overcomes these problems and improves the physical health and well being of womem. The present findings reveals that solar cooking is the successful method for different preparation and for better retention of vitamins and minerals as compared to pressure cooking and boiling.

The recommendations evolved from the present study are:

1. By using the similar method the effect of solar cooking on other food groups can also be foundout.

2. Comparative evaluation of all types of solar cookers can be carried out.

3. Popularisation of solar cookers in rural and urban areas could be undertaken.

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APPENDIX

APPENDIX - I

SCORE CARD

NAME DATE :

	SCORE	246	312	459	523	664	797
1. Appearance							
Excellent	5						
V.Good	4						
Good	3						
Fair	2						
Poor	1						
2. Flavour							
Excellent	5						
V.Good	4						
Good	3						
Fair	2						
Poor	1						
3. Colour							
(i) Bengalgram							
(ii) Cowpea							
(iii) Fieldbeans							
(iv) Redgram							

	SCORE	246	312	459	523	664	797
V. Light Brown	5						
Light Brown	4						
Golden Brown	3						
Dark Brown	2						
V. Dark Brown	1						
Greengram, Peas							
V. Light Green	5						
Light green	4						
Green (Raw)	3						
Dark Green	2						
V. Dark Green	1						
4. Texture							
V. Soft	5						
Soft	4						
Smooth	3						
Tough	2						
V. Tough	1						
5. Taste							
Excellent	5						
V.Good	4						
Good	3						
Fair	2						
Poor	1						

APPENDIX - II

PROTEIN CONTENT (In g/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw			Boiled			Pressure Cooked			Solar Cooked		
		I	II	III	I	II	III	I	II	III	I	II	III
1.	Bengalgram	14.3	12.2	12.2	10.2	11.0	11.0	10.9	11.8	11.8	11.2	11.9	11.9
2.	Cowpea	17.0	17.0	18.5	14.6	14.6	13.3	15.4	15.4	14.2	16.1	16.1	15.8
3.	Fieldbeans	20.5	17.5	17.5	15.0	15.2	15.2	16.4	17.0	17.0	17.2	17.0	17.0
4.	Greengram	17.5	17.0	17.0	15.0	15.0	15.4	16.2	16.2	16.3	16.6	16.6	16.5
5.	Horsegram	16.8	16.2	16.2	14.7	15.0	15.0	15.1	15.5	15.5	15.0	15.7	15.7
6.	Peas	15.5	15.0	15.0	13.3	13.3	13.4	14.4	14.4	14.0	14.6	14.6	14.5
7.	Redgram	22.5	22.5	21.9	20.0	20.4	20.4	20.4	20.8	21.2	20.8	21.5	21.5

APPENDIX - III

THAIMINE CONTENT (In mg/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw			Boiled			Pressure Cooked			Solar Cooked		
		I	II	III	I	II	III	I	II	III	I	II	III
1.	Bengalgram	0.31	0.29	0.29	0.21	0.20	0.20	0.24	0.21	0.21	0.24	0.22	0.22
2.	Cowpea	0.31	0.41	0.41	0.30	0.29	0.29	0.31	0.34	0.34	0.33	0.36	0.36
3.	Fieldbeans	0.36	0.41	0.41	0.28	0.30	0.30	0.31	0.33	0.33	0.31	0.36	0.36
4.	Greengram	0.29	0.33	0.33	0.20	0.23	0.23	0.25	0.26	0.26	0.26	0.28	0.28
5.	Horsegram	0.28	0.33	0.33	0.25	0.24	0.24	0.27	0.28	0.28	0.28	0.29	0.29
6.	Peas	0.27	0.31	0.31	0.21	0.23	0.23	0.24	0.26	0.26	0.26	0.27	0.27
7.	Redgram	0.20	0.22	0.22	0.18	0.16	0.16	0.15	0.17	0.17	20.0	0.19	0.19

APPENDIX - IV

RIBOFLAVIN CONTENT (Inmg/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw			Boiled			Pressure Cooked			Solar Cooked		
		I	II	III	I	II	III	I	II	III	I	II	III
1.	Bengalgram	0.11	0.13	0.13	0.09	0.10	0.10	0.12	0.11	0.11	0.11	0.12	0.12
2.	Cowpea	0.14	0.15	0.15	0.10	0.11	0.11	0.14	0.13	0.13	0.15	0.14	0.14
3.	Fieldbeans	0.10	0.09	0.09	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08
4.	Greengram	0.21	0.20	0.20	0.16	0.16	0.17	0.18	0.18	0.18	0.19	0.19	0.18
5.	Horsegram	0.12	0.14	0.14	0.10	0.11	0.11	0.13	0.12	0.12	0.12	0.13	0.13
6.	Peas	0.10	0.09	0.09	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08
7.	Redgram	0.17	0.18	0.18	0.15	0.14	0.14	0.15	0.16	0.16	0.18	0.17	0.17

APPENDIX - V

CALCIUM CONTENT (In mg/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw			Boiled			Pressure Cooked			Solar Cooked		
		I	II	III	I	II	III	I	II	III	I	II	III
1.	Bengalgram	124	136	136	115	115	112	127	127	128	132	132	135
2.	Cowpea	64	60	60	45	47	47	55	55	56	54	56	56
3.	Fieldbeans	52	52	58	44	44	45	47	47	46	49	49	50
4.	Greengram	112	108	108	96	96	98	100	100	101	102	102	103
5.	Horsegram	204	208	208	181	181	183	199	199	197	203	203	201
6.	Peas	60	60	66	43	45	45	52	53	53	59	58	58
7.	Redgram	183	180	180	163	163	165	174	174	175	176	176	174

APPENDIX - VI

PHOSPHORUS CONTENT (In mg/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw			Boiled			Pressure Cooked			Solar Cooked		
		I	II	III	I	II	III	I	II	III	I	II	III
1.	Bengalgram	218	224	224	201.1	202.2	202.2	218	216.4	216.4	220.3	217.4	217.4
2.	Cowpea	342	350	350	313	313	315	322	322	320	328	328	330
3.	Fieldbeans	358	304	304	281	281	283	288.4	288.4	290	237	291.1	291.1
4.	Greengram	256	256	264	220.1	223.2	223.2	232	235	235	235	237.3	237.3
5.	Horsegram	224	224	232	206	207	207	209.3	209.3	209.3	215	214.7	214.7
6.	Peas	232	240	240	223.2	223.2	224	228	228	228	238.4	230.4	230.4
7.	Redgram	256	288	288	265	264.1	264.1	268.1	269.2	269.2	267.3	270.6	270.6

APPENDIX - VII

IRON CONTENT (In mg/100g) OF THE RAW AND COOKED PULSES

S.No.	Pulses	Raw			Boiled			Pressure Cooked			Solar Cooked		
		I	II	III	I	II	III	I	II	III	I	II	III
1.	Bengalgram	5.2	4.0	4.0	4.2	3.7	3.7	4.4	3.9	3.9	4.4	3.9	3.9
2.	Cowpea	7.5	7.5	8.0	6.7	6.7	7.0	7.2	7.2	7.4	7.2	7.2	7.4
3.	Fieldbeans	2.0	2.0	2.0	1.7	1.8	1.8	1.8	1.9	1.9	1.8	1.9	1.9
4.	Greengram	5.2	4.0	4.0	3.6	3.6	3.5	3.7	3.7	3.6	3.7	3.7	3.6
5.	Horsegram	8.0	7.5	7.5	6.8	6.7	6.7	7.1	7.0	7.0	7.2	7.1	7.1
6.	Peas	6.5	6.5	7.0	5.8	5.8	5.9	6.0	6.0	6.1	6.0	6.0	6.1
7.	Redgram	1.5	1.5	1.5	1.2	1.3	1.3	1.3	1.4	1.4	1.5	1.4	1.4