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EFFECT OF PRESSURE COOKING AND MICROWAVE COOKING ON THE NUTRITIONAL QUALITY OF SELECTED LEGUMES

[1]Kanchana.V, [2] Anna Rangini Chellappa.

[1] Research Scholar, [2] Associate Professor and Head

[1]Department of Home Science,

[1] Queen Mary's College, Chennai, India

Abstract: Legumes are widely grown throughout the word and their dietary and economic importance is globally appreciated and recognized. However, heat treatments are known to alter the nutrient content of legumes. Pressure cooking and microwave cooking have been reported to be used often in the cooking of legumes. However, there is a tremendous dearth of information on the effect of these cooking techniques on the nutrient quality of legumes. Chick pea and green gram have known to be widely used in India households. Since there is very little information on the effect of heat treatment on the nutritional quality of these two legumes we carried out this study to examine the effect of pressure cooking and microwave cooking on specific nutrients such as protein, total amino acid, thiamine, niacin and pyridoxine of both chick pea and green gram using standard procedures. In this experimental study, 1 kg of chick pea and green gram were purchased from the local market and were soaked in distilled water for 12 hours at room temperature and drained. After soaking, 100g of the chick pea and green gram were pressure cooked for 15 minutes and 10 minutes respectively at 120°C. Similarly, 100g chick pea and green gram was cooked in the microwave oven for 20 minutes and 15 minutes respectively in high temperature mode. The cooked legumes were kept in room temperature and ground in a blender without adding water. Cooking treatments were replicated three times. The samples were aseptically packed in air tight containers and subjected to nutrient analysis using standard procedures. Inter group comparisons were done using Analysis of Variance and Duncan's Multiple Range Test. Pressure cooking was found to be more effective in the retention of protein, total amino acid, thiamine, riboflavin, pyridoxine and niacin content of chick pea and green gram when compared to microwave cooking.

Index Terms **- Legumes. Microwave cooking, Pressure cooking, Nutrient content**

I. INTRODUCTION

Legumes are known to provide both environmental and nutritional benefits and are valued worldwide as a sustainable and inexpensive food, the second most important food source after cereals (Gallego et al. 2021, Marielle et al.2018, Maphosa and Victoria, 2017). Legumes are known for its nutritional density providing low fat source of proteins (20–45%) and carbohydrate (±60%) with essential amino acids, and dietary fibre (5–37%). Legumes also have no cholesterol and are generally low in fat, with ±5% energy from fat, with the exception of peanuts (±45%), chickpeas (±15%) and soybeans (±47%) and provide essential minerals and vitamins (Gallego et al.2021, Marielle et al. 2018, Maphosa and Victoria, 2017and Adriana et al.2016).· In addition to their nutritional significance, legumes have also gained popularity due to their economic, cultural, physiological and medicinal roles due to the presence of beneficial bioactive compounds in them.

In the Indian context, legumes have been cultivated from time immemorial. Due to their high protein content, they have been considered as the "poor man's meat". In the present context of our economic development, exploitation of protein rich legumes in the diet in combination with cereals appears to be a feasible approach to eliminate protein –calorie malnutrition in the near future (Khattak et al, 2008). Among the various legumes, chicken pea (*Cicer arietinum*) and green gram (*Phaseolus aureus*) seeds are an important and cheap source of legume protein which can be used as a substitute for animal protein (Pallertier,1994).

Despite the nutritional benefits of legumes, it is well established that cooking and thermal treatments in general usually cause losses in food product nutritional quality and phytochemical contents. However, they can also inactivate heat labile anti nutritional factors such as pulse antitrypsin factors that adversely affect protein bioavailability, decrease pulse content in unwanted factors such as phytates or modulate pulse amino acid composition and protein digestibility (Marielle et al. 2018, Aviles-Gaxiola et al. 2018 , Nosworthy et al.2018). Most of the studies conducted so far to determine the effect of cooking on nutrient quality of legume composition have focused either on one pulse, or on limited nutrients and the results have been inconsistent.(Daur et al.2008, Barampama et al. 1995, Attia et al. 1994, Grewal and Jood,2006). In India, pressure cooking of pulses has been the most common method of cooking. Microwave cooking has also gained considerable importance as an energy-saving, convenient and timesaving cooking method (Rashid et al, 2016) . The aim of this work was to investigate the effect of pressure cooking and microwave cooking on specific nutrients viz., protein , total amino acid, thiamine, riboflavin, pyridoxine and niacin content in chick pea and green gram. These two legumes were chosen as they are commonly consumed in Indian households. The values obtained in the cooked samples were compared with that of raw legumes.

II. RESEARCH METHODOLGY

2.1 Study Design

An experimental study design was adopted to investigate the effect of pressure cooking and microwave cooking on specific nutrients viz., protein , total amino acid, thiamin riboflavin, pyridoxine and niacin content in chick pea and green gram. This study was carried out at Queen Mary's College, Chennai 600004.

2.2 Sample Selection

One kg of Chick Peas (*Cicer Arietinum*) and green gram (*Phaseolus aureus*) were purchased from the local market in Chennai . The legumes were hand sorted to remove wrinkled mouldy seeds and foreign material.

2.3 Sample preparation

Chick pea and green gram were soaked separately in distilled water for 12 hours at room temperature. The soaked seeds were drained and rinsed three times with 600ml distilled water. After it was drained, 100g of chick pea and green gram were measured separately. For the pressure-cooking process, the soaked chick pea seeds were pressure cooked for 15 minutes at 120°C while green gram was cooked for 10 minutes at 120°C.The legumes were cooled to room temperature and ground without water in a blender. Micro wave cooking of the soaked chick pea and green gram was carried out in microwave for 20minutes and 15 minutes respectively in the high temperature mode. The legumes were cooled to room temperature and ground without water in a blender. All cooking treatments were replicated three times. The sample was packed in clean air tight containers and subjected to nutrient analysis following standard procedures.

2.4Nutrient analysis of the sample

Protein content was assessed using the Kjeldahl method (Raghuramalu et al, 2003) .The nitrogen estimation is based on the principle that the organic nitrogen when digested with sulphuric acid in the presence of a catalyst is converted to ammonium sulphate. Ammonium liberated by making the solution alkaline was distilled into known volume of standard acid, which was then back –titrated. The protein content was obtained by multiplying the nitrogen value with 6.25. Amino acid was assessed using paper chromatography. A homogenous powder was made of the foodstuff. 1gm of this powder was extracted in 100ml of 70% alcohol for about 8 hours with occasional stirring. The extract was filtered using Whatman No1 filter paper and the clear alcoholic extract was evaporated to dryness on steam bath. The residue was then taken up in 10ml of 10% isopropanol and filtered and the clear extract was used for spotting. This extract was stored at 40°C. Twenty µl of this extract was used for ascending or descending chromatography. The amino acid content in the unknown tubes was determined by interpolation of titre values on the standard curve. Then the amino acid was calculated from the average of the values for 1ml of the test solution. Vitamin content viz., thiamine, riboflavin and niacin of the sample was assessed using High Performance Liquid Chromatography (HPLC).Thiamine assessment is based on the oxidation of thiamine to thiochrome, which fluoresces in UV light under standard condition and in the absence of other fluorescing substances. The fluorescence is proportional to the thiochrome present and hence to the originality of the condition. For the riboflavin estimation the native fluorescent of riboflavin in neutral pH was used. The assessment of niacin content using HPLC is based on the principle that nicotinic acid reacts with cyanogens bromide and aromatic amines like aniline to give a yellow colored compound which is measured calorimetrically . Pyridoxine was estimated microbiologically using Saccharomyces carlsbergensis as assay organism (Raghuramalu et al. 2003)

2.5 Statistical analysis

Data was analyzed using SPSS version 13 (SPSS Inc., Chicago, IL). The data obtained were coded tabulated and subjected to analysis of variance. Intergroup comparisons were done using Analysis of Covariance and Duncan's Multiple Range Test to test for differences in proportions of categorical variables between two or more groups. The level $P < 0.05$ was considered as the cutoff value or significance

III. RESULTS AND DISCUSSION

3.1 Results of Analysis of Variance and Dunce's Multiple Range Test

Table 3.1 and Fig.1 Shows mean and SD of protein , total amino acid, thiamine, riboflavin, pyridoxine and niacin content of uncooked, pressure cooked and microwave cooked chick peas

Table 3.1: Comparison of the protein, total amino acid, thiamine, riboflavin, pyridoxine and niacin content of uncooked, pressure cooked and microwave cooked chick peas

Nutrient	Uncooked chick peas (UC)	Pressure cooked chick peas (PC)	Microwave cooked chick pea (MC)
Protein g	17.14±.037	16.14±.30[1a]	15.95±.022 [2a,3a]
Total amino acid (g)	7.36±.036	3.15±.047[1a]	2.96±0.26 [2a,3a]
Thiamine (mg)	0.49±0.002	0.47±.002[1a]	0.34±.003[2a,3a]
Riboflavin(mg	0.18±0.03	0.177±.001[1c]	0.174±.002 [2c 3c]
Pyridoxine(mg	2.36±0.29	0.66±0.00[1a]	0.09±.002[2a,3a]
Niacin (mg	2.86±0.01	2.62±0.22[1c]	2.56±0.21[2c 3c]

Values in the row with different superscript letters and numbers show differences between groups in Mean ±SE content of estimated nutrients of [1] UC vs PC, [2] UC vs MC, [3] PC vs MC, on a given test .[a] Significant differences between groups ,P< 0.01 level , [b] Significant differences between groups ,P< 0.05 level [c] No Significant differences between groups

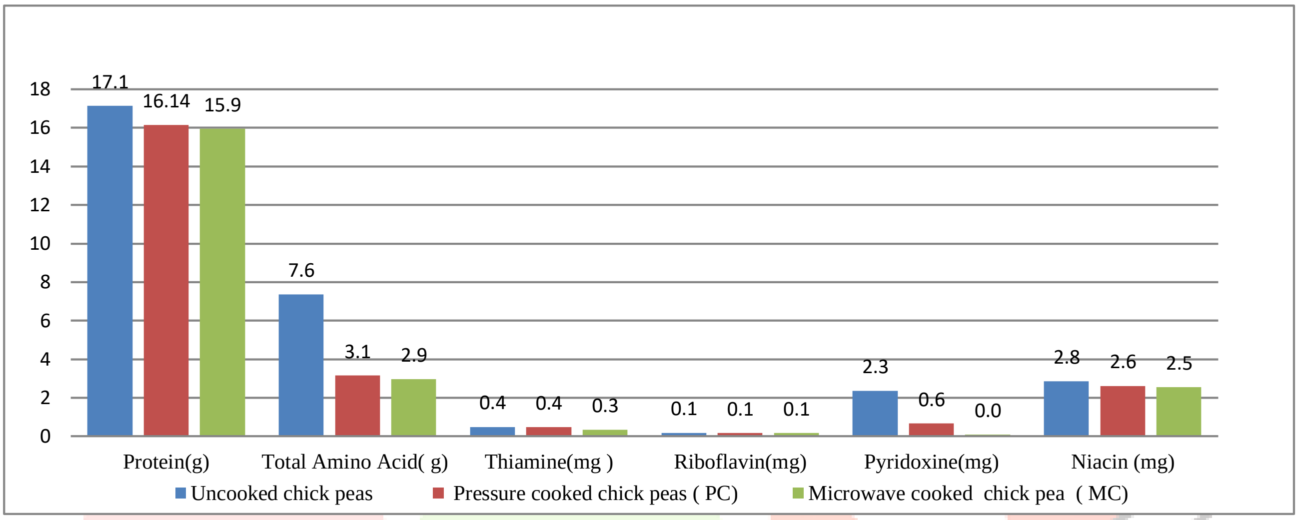

Figure 1. Nutrient content of uncooked, pressure-cooked and microwave cooked chick pea

. The above table 3.1 demonstrates that the protein content of uncooked chick pea **(**17.14±.037g) decreased after it was subjected to cooking methods viz., pressure cooking (16.14±.30g,) and microwave cooking (15.95±.022g), with maximum retention observed in pressure cooked chick pea (P< 0.01) .Similarly, heat processing methods also significantly reduced (P< 0.01) the total amino acid content in pressure cooked chick pea (3.15±.047g) and microwave cooked chick pea (2.96±0.26g) when compared to that of uncooked chick peas. (7.36±.036g). The amino acid retention was lowest (P< 0.01) in microwave cooked chick peas. These results indicate that processing conditions modify the structure of proteins and/or the food matrix (Gallego et al,2021).

The thiamin and pyridoxine content of uncooked chick peas was 0.49±0.002mg and 2.36±0.29 mg respectively. After cooking, pressure cooked chick peas showed the highest retention of thiamine (0.47±.002mg) and pyridoxine (0.66±0.00 mg) compared to the microwaved cooked chick peas (P< 0.01). The thiamine content of microwave cooked chick peas was 0.34±.003mg and pyridoxine content was 0.09±.002 mg respectively . There was no significant difference in the loss of niacin and riboflavin in pressure cooked and microwaved cooked chick pea.

Table 3.2 Comparison of the protein, total amino acid, thiamine, riboflavin, pyridoxine and niacin content of uncooked, pressure cooked and microwave cooked green gram

Nutrient	**Uncooked green gram (UG)**	**Pressure cooked green gram (PG)**	**Microwave cooked green gram (MG)**
Protein g	24.04±.04	20.75±.04[1a]	20.18±.0.18 [2a,3a]
Total amino acid (g)	5.84±.0.17	3.75±.003[1a]	3.47±0.26 [2a,3a]
Thiamine (mg)	0.50±0.03	0.39±.003[1a]	0.46±.02[2a,3a]
Riboflavin(mg	0.30±0.02	0.19±.03[1a]	0.20±.01 [2a 3a]
Pyridoxine(mg	1.35±0.17	0.49±0.00[1a]	0.10±.003[2a,3a]
Niacin (mg	6.51±0.003	5.03±0.22[1a]	2.14±0.03[2a 3a]

Values in the row with different superscript letters and numbers show differences between groups in Mean ±SE content of estimated nutrients of [1] UC vs PC, [2] UC vs MC, [3] PC vs MC, on a given test a [a]Significant differences between groups ,P< 0.01 level , [b] Significant differences between groups ,P< 0.05 level [c] No Significant differences between groups

Table 3.2 and Fig 2 Show the mean and SD of protein , total amino acid, thiamine, riboflavin, pyridoxine and niacin content of uncooked, pressure cooked and microwave cooked green gram . After pressure cooking and microwave cooking, the protein content of pressure cooked green gram reduced to 20.75±.04g and 20.18±.0.18g in microwave cooked green gram. The retention of protein was lowest (P< 0.01) in microwave cooked green gram compared to pressure cooked green gram. Like in the case of proteins, a significant loss (P< 0.01) in total amino acid content was seen in pressure cooked green gram (3.75±.003 g) and microwave cooked green gram (3.47±0.26g) compared to the total amino acid content of uncooked green gram (5.84±.0.17g). Further, pressure cooking resulted in significant loss (P<0.01) of thiamine(0.39±.003 mg); riboflavin (0.19±.03 mg) pyridoxine (0.49±0.00 mg) and niacin content(5.03±0.22 mg) compared to the vitamin content of uncooked green gram viz., thiamine(0.50±0.03mg), riboflavin (0.30±0.02 mg), pyridoxine (1.35±0.17 mg) and niacin (6.51±0.003).Microwave cooked gram gram showed the lowest retention (P<0.01) of thiamine(0.46±.02 mg), riboflavin (0.20±.01mg) , pyridoxine (0.10±.003 mg) and niacin (2.14±0.03 mg).

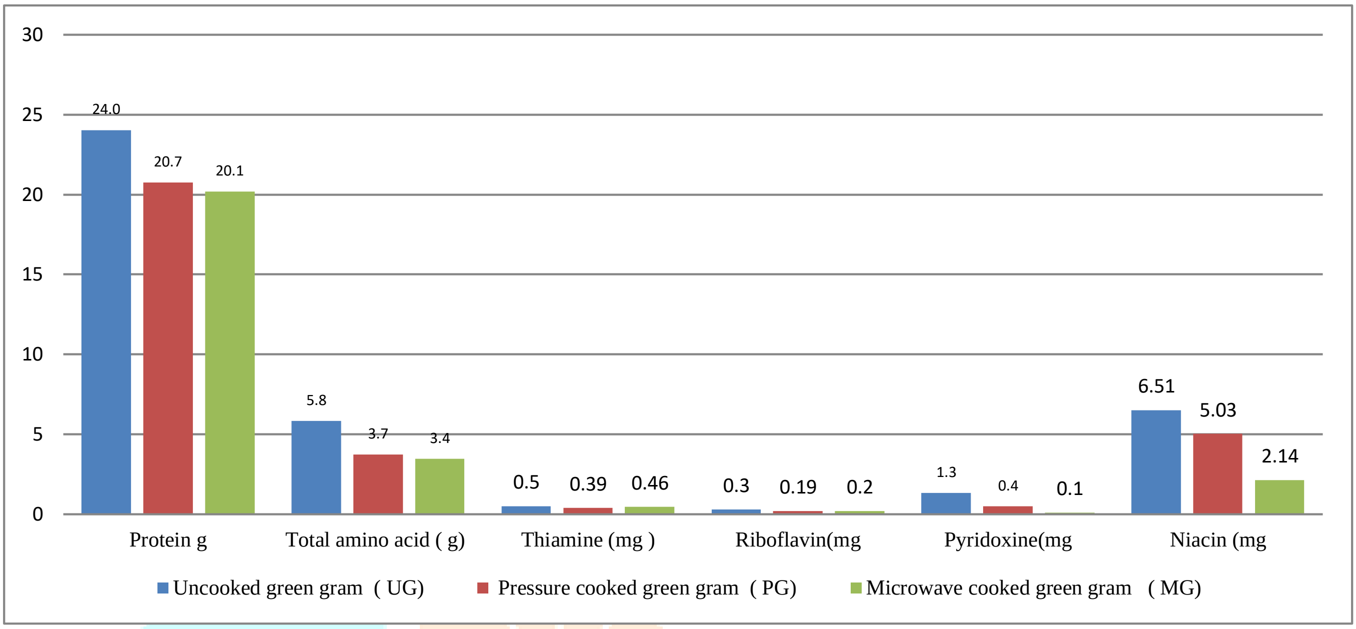

Figure 2. Nutrient content of uncooked, pressure-cooked and microwave cooked green gram

3.2 Discussion

Legumes such as chick pea and green gram are nutrient dense and are important components of the human diet. Recent studies have demonstrated that the method of preparation and cooking can affect the nutrition quality of food. These two steps induce several changes and interactions among its constituents, in some cases positive, in others negative. Traditional home preparation of legumes such as green gram and chick peas is primarily aimed at making them more digestible palatable and improving their flavor. There is little attention paid to its nutritional value. Nutritional composition of green gram and chick peas as influenced by cooking periods has been seldom studied. Therefore, knowing the changes occurring in food from preparation to table is essential not to only for scientific research, but also for the consumer, who can make decisions about how to prepare and cook these healthy legumes

Since the early part of the twentieth century many studies have been conducted to investigate the impact of preparation and cooking methods on the stability of nutrients in food. The results of these studies vary widely leading the consumer to question the best ways of preparing and cooking foods in order to maintain the nutritional qualities of food (Adriana et al.2016).Nutrients may be lost during cooking in two ways: first, by degradation which can occur by chemical changes such as oxidation and secondly by leaching into the cooking medium(Otemuyiwa et al.2018, Berechet and Segal,2007) . Hence the knowledge of how these foods are prepared and how these different methods of preparation affect the nutritional quality of the food is extremely relevant for today's consumer.

It is well known that processing of food is generally a prerequisite for improving the digestibility and palatability of foodstuffs. The methods involved in the processing of foods vary widely, and the nutritive value of food may be improved or diminished depending on the methods employed. Among the several methods of cooking, microwaving, roasting, boiling, steaming and pressure cooking have been recognized as popular methods (Adriana et al.2016, Li et al.2019). In pressure cooking, the steam is not allowed to leave the pressure pot which causes the pressure sitting on the content. A pile up of the pressure causes a rise in the temperature of the boiling water making it boil at a temperature greater than 100º C which causes an increase in the rate of the reaction (Otemuyiwa et al.2018) . It is well known that pressure cooking increases starch digestibility as well as reduces the level of anti-nutrients (Adriana et al. 2016) . However, the effects of pressure cooking on nutrient loss have been inconsistent. Some studies have showed that nutrient retention was higher in pressure cooked foods (Deol and Bains,2010) while some others have reported greater loss of vitamins (Raju et al.2017).

Microwave processing has also attracted attention both in academic research and industry (Li et al. 2019). The mechanism of dielectric heating is quite distinct from that of the traditional conduction heating, and is widely applied as polar molecules and charged ions interaction with the alternative electromagnetic fields, resulting in fast and volumetric heating through their friction losses(Jiang et al. 2017). Different from conventional heating methods, heat is generated within the product during microwave treatment due to molecular friction resulting from oscillating dipole molecules and migrating ions caused by the applied alternating electric field. Therefore, microwave heating is expected to deliver more homogenous heat at a faster rate than slow conventional heating, which relies on the processes' conduction and convection to transport heat from the heating sources to the product(Jiang et al .2017,Li et al.2019,) .Although microwave heating techniques with its several advantages especially with regard to speed and ease in cooking have been successfully used for many food processes, studies have shown that this method of cooking leads to negatively impaired vitamin content (Brown et al. 2020, Otemuyiwa et al.2018) and also results in denaturation of protein (Li et al.2019) .

In this context, the present experimental study was conducted to evaluate the effect of pressure cooking and microwave cooking on specific nutrients such as protein, total amino acid, thiamine, niacin and pyridoxine in both chick pea and green gram. The study shows that both pressure cooking and microwave cooking resulted in loss of protein and amino acid, the loss being higher in microwave cooked chick pea and green gram when compared to uncooked chick pea and green gram.

Assessing the availability of protein from foods is crucial since proteins play critical roles in nearly all biological processes, including catalyzing metabolic reactions and DNA replication, responding to stimuli, and transporting molecules from one location to another (Jiang et al 2017, Burgess and Deutscher ,2009) The significant loss in protein and amino acid retention in microwave cooked chick pea and green gram in the present study could be due to the fact that proteins and peptides have higher dielectric constant. As a result, microwave irradiation may have had a significant impact on their activity and structure (Jiang et al.2017, Plagemann et al.2014). The results could also be attributed to the fact that microwave treatment has a significant effect on protein degradation and accelerating reaction(Raju et al.2017)· It was also reported that solutions heated using microwave exhibit more extensive protein aggregation than conventionally heated ones (Gomaa et al. 2013) The higher retention of protein and amino acid in pressure cooked chick peas observed in the study is in accordance with that of earlier studies which reported that pressure treatment is generally considered to be less destructive to the food and food ingredients (Michel M., Autio K,2001).

The present study also examined the effect of pressure cooking and microwave cooking on the vitamin content of chick pea and green gram. Such systematic studies on the effect of cooking methods on vitamins is of paramount importance since vitamins are organic compounds and vital nutrients that cannot be synthesized and thus must be obtained through the diet. Although vitamins are usually needed in minute amounts for normal physiological functions such as maintenance, growth, and development, insufficient intake of vitamins gives rise to specific deficiency syndromes (Lee et al, 2018**) .**

On assessing the effect of cooking methods on the vitamin content of the selected legumes, the study revealed that both cooking methods negatively impaired the thiamine and pyridoxine content of chick peas and green gram . However, the loss was more in microwave cooked legumes than pressure cooked legumes. These results are consistent with several studies that have proved the beneficial effect of steaming and pressure cooking in retaining nutrients during cooking (Adriana et al,2016). The trend of thiamine loss in this study is consistent with the observation of Berechet and Segal (2007) who also reported destruction of thiamine under heat processing. Surprisingly, the results showed a lack of significant difference in niacin and riboflavin content of microwave cooked and pressure-cooked chick peas. However, in green gram a significant loss of niacin and riboflavin was observed due to pressure cooking and microwave cooking, the loss being more in microwave cooked green gram. The significant loss of B vitamins in microwave cooked legumes cooked be attributed to microwave power which could be the main reason for the vitamin degradation (Barba et al ,2015,Raju et al 2017). However, the inconsistent trend observed with regard to the negative effect of microwave cooking on riboflavin and niacin content in chick pea and green gram needs to be further examined and ascertained

IV CONCLUSION

The study revealed that although both cooking methods viz ., pressure cooking and microwave cooking negatively impaired protein , total amino acid , thiamine, riboflavin, pyridoxine and niacin content of green gram and chick pea, the loss was more with microwave cooked green gram and chick peas. Pressure cooking was found to be more effective in the retention of the nutrients that were assessed in both chick pea and green gram . It is therefore important to encourage cooking practices that will ensure retention of proteins, vitamins and other nutrients. Otherwise, foods cooked or warmed with modern technological devices like microwave should be complemented with food sources such as raw fruits vegetables sand sprouted legumes for a balanced vitamin nutriture

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