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**Research Report**

# Nutrient Analysis of Raw vs. Processed Chickpea (Cicer arietinum) and Development of Value Added Products

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## ABSTRACT

*Chickpea (Cicer arietinum) is a pulse crop. It occupies an important place in human nutrition and is a valuable source of protein, fiber and minerals. Being nutritionally important it was taken for the present study for bio chemical analysis of nutrients and development of value added products.*

*Raw seeds were grounded along with husk to obtain chickpea flour which was analyzed biochemically for the nutrients i.e. moisture, ash, crude-fiber, protein, carbohydrate, fat, calcium, phosphorous, iron, zinc and folic acid.*

*Whole seeds were subjected to various treatments like roasting, soaking for 10 hrs. and germinating the soaked seeds for 24 hrs. and 48 hrs. They were then dried, powdered and nutrients analyzed.*

*Khakra, bread, pizza-base and bun are commonly consumed market products by all age groups in states of Rajasthan and Gujarat. These are made of flour which is not high in fiber. Such low fiber diets are reported to be a major cause of diseases like obesity, diabetes, cardiovascular etc. Enhancement of fiber in diet led to the development of value added products. Being high in fiber the chickpea powder (raw) was used for this investigation.*

*Two types of incorporations were done for bread, pizza base and bun:*

*(a) Refined flour and chickpea flour in the ratio 70:30*

*(b) Wheat flour, refined flour and chickpea flour, in ratio 40:30:30*

*For Khakra, chickpea and wheat flour were used in ratio 40:60*

*Sensory evaluation of these products was done, which showed that the acceptability of both the types of developed products in terms of texture, taste, appearance and overall acceptability remained same as compared to that of market products.*

*Statistical analysis of results of biochemical analysis and sensory evaluation was done using ANOVA.*

*Nutrient analysis /100g of the developed products done using Nutritive Value of Indian Foods suggests that the products made of 40:30:30 ratio (wheat flour, refined flour, chickpea flour) were higher in protein and fiber so were more acceptable than products with 70:30 ratio (refined flour, chickpea flour).*

*It may therefore be concluded that the use of chickpea flour substantially increased the protein and fiber content. To obtain better nutrients the consumption of these value added developed products may be recommended. This would also help to prevent the life style diseases like obesity, diabetes, cardiovascular etc.*

**KEYWORDS:** Bengal grams, Dietary fiber, Life style diseases

## INTRODUCTION

Life cannot be sustained without adequate nourishment. Food is that which nourishes our body. Man needs food for growth, development and to lead an active and healthy life. It may be defined as anything eaten or drunk, which can be absorbed by our body to be used as an energy source. In other words, it is the raw material from which our body is made. Intake of the right kind and amount of food ensures good health, which reflects our physical appearance, emotional well being and energy to perform daily activities[1]. The word "Nutrition" comes from the Latin word "Nutr." meaning "to nurture or to nourish". Nourishment is that which sustains life. A broader definition includes the social, economical, cultural and psychological implication of food and eating[2].

The science of nutrition had its beginning during the late eighteenth century with the discovery of the respiratory gases and especially the studies on nature and the qualification of energy metabolism by Lavishers, referred to as the "Father of the science of nutrition". In a survey in the nineteenth century many chemists and physiologists added important information on the need for protein and some other minerals like calcium, phosphorous and iron. Knowledge of vitamins has been gained in the twentieth century. Indeed more knowledge concerning nutrition has been gained during this century. Nutrition is the finest need of man: his general health and well-being are much dependent on his nutritional status[3]. It is the contribution of processes by which the living organism receives, utilizes the materials necessary for the maintenance of its function, for growth and renewal of its components. It is the science that interprets the relationship of food to the function of the living organization and also the processes by which our body uses the food. Good health is a state of complete physical, mental, social well being and not merely the absence of disease or infinity.

Swaminathan[4] classified food into eleven groups on the basis of their nutritive value:

(1) Cereals

(2) Pulses and legumes

(3) Nuts and oil seeds

(4) Vegetables

(5) Fruits

(6) Milk and milk products

(7) Egg, meat, fish and other animal foods

(9) Fats and Oil

(10) Sugar and other carbohydrate foods

(11) Spices and condiments

**Chickpea**

Chickpea commonly called gram or Bengal gram is the most important pulse crop. It is a cool season crop i.e. Rabi crop, ranks second in area and third in production among pulses in the world. It is the world's third most important grain legume after beans and peas[5]. It covers an area of 5.81 million hectares with the production of 3.62 million tons in India. It represents about 27% of total area under pulses production in our country.

The scientific name of chick pea is Cicer arietinum. Cicer name is of Latin origin and genus Cicer belongs to family Leguminosae. Legumes are next in importance to cereals as sources of human and animal food and are widely grown throughout the world. They are rich sources of protein in our diets which is about 20-40%. From the point of nutrition they are very important as protein content in pulses is double than that of wheat and thrice than that of rice. For this reason they are called "Poor man's meat". In a vegetarian diet or a diet containing low animal food, they are an important source of protein. Chief protein is globulin called "legumin"[6].

Legumes not only have a dietary value but play an important role in maintaining and improving soil fertility through their ability to fix atmosphere nitrogen. They also serve as economical sources of minerals like calcium, magnesium, iron, zinc and potassium.

There is widespread protein calorie malnutrition in the developing countries and pulses can play an important role in bridging the protein gap.

**Figure 1:** Flowering Chickpea Plant

**Origin and History**

The grain is said to be one of the oldest pulses known and cultivated from ancient times both in Asia and Europe. It probably originated in an area of present day south east Turkey and adjoining Syria. Botanical and archaeological evidence show that chickpea was first domesticated in the Middle East and was widely cultivated in India.

Chick pea has been introduced all over the world and is the most important legume grown in India mostly in Madhya Pradesh, Rajasthan, Uttar Pradesh, Maharashtra, Haryana, Karnataka, Bihar and Gujarat.

In Rajasthan, chick pea is cultivated in Ajmer, Jaipur, Dausa, Sikar, Jhunjhunu, Alwar, Bharatpur, Dholpur, Sawai Madhopur, Karauli, Bikaner, Churu, Ganganagar, Hanumangarh, Jaisalmer, Jalore, Pali, Sirohi, Kota, Baran, Bundi, Jhalawar, Tonk, Banswara, Dungarpur and Udaipur. According to the statement of Agriculture Secretariat, Jaipur the production achieved in Rajasthan was 120.0 tonnes in 101.8 hectares area yield on kg/hectare in 2004-2005.

**Classification**

Cicer was originally classified as tribe vicieae but its portion is sufficiently distinct to consider the genus a tribe of its own, the Cicerae[7]. There are 43 species of Cicer (cultivated and wild) throughout the world.

The Indian gram has been classified into two broad categories:

**(1) Desi or brown gram (Cicer arietinum):** It is most widely grown. The color often varies from brown to yellow. The flower color may be white, pink or blue. Seed size varies from 5-12 mm. Stem is erect to semi-bending and plant has a good branching ability. Desi type seeds are used in both forms green as well as dry. The green seeds are used as "chhole" for vegetable purpose and "chola" as a roasted form. The dry seeds are puffed and called “chana".

**(2) Kabuli or White Gram (Cicerkabuli):** Plants of this group have a poor yield potential than desi type. Grains are bold and attractive and usually white in colour. Plants are tall and erect with moderate branching ability.

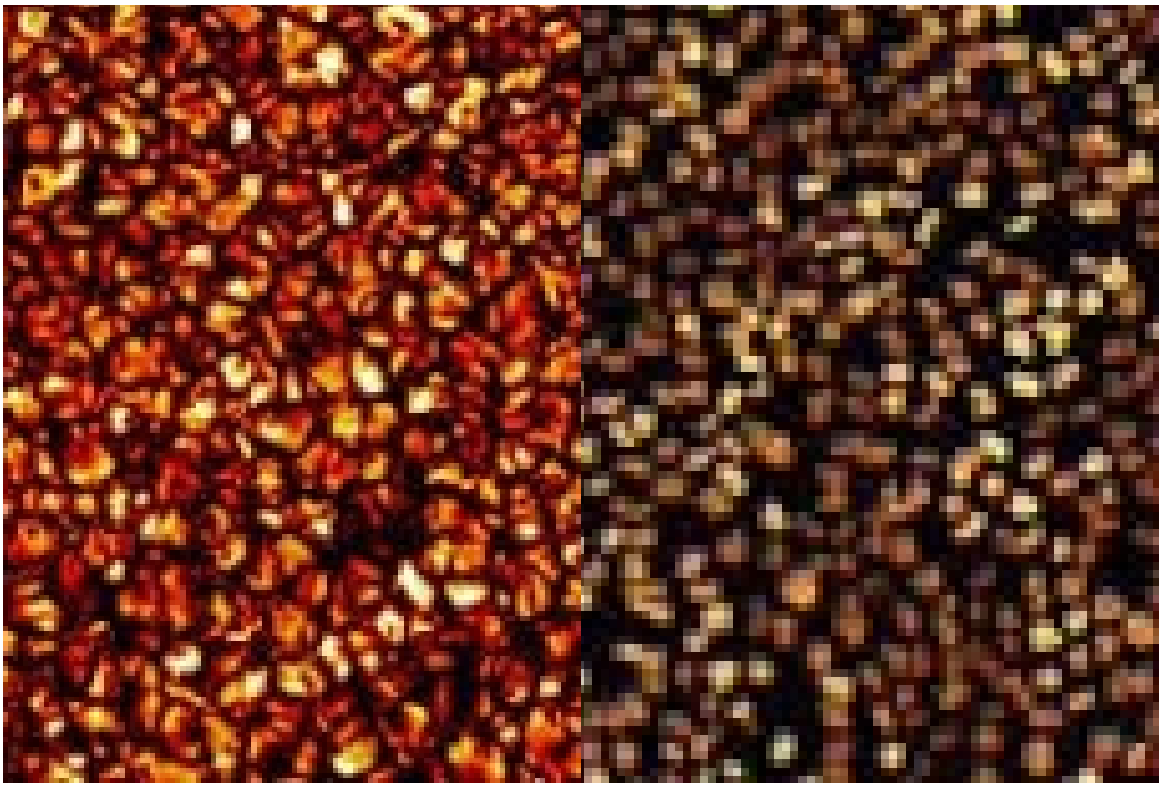

**Figure 2:** Chickpea Desi
Left: Bengal variety; Right: European variety

**Figure 3:** Chickpea Kabuli
White and Green Chickpeas

**Nutritional Composition**

Seed has 38.59% carbohydrate, 3% fiber, 4.8-5.5% oil, 3% ash, 0.2% calcium, and 0.3% phosphorous. Digestibility of protein varies from 76-78% and its carbohydrate from 57-60%[8,9]. Accordingly to the International crops Research Institute for the Semi Arid Tropics (ICRISAT)[10] chick pea seeds contain on an average:

23% - Protein

64% - Total Carbohydrates (47% starch, 6% soluble sugar)

5% - Fat

6% - Dietary Fiber

3% - Ash

**Nutrients in Chickpea**

**(1) Protein and Amino acid**

Chickpea seeds contain protein that ranges between 12.6 and 30.5%. The protein content of Dal is higher than that of the whole seed indicating the effect of seed coat on the protein content in chickpea genotypes. They also contain a considerable amount of protein nitrogen (NPN), which also affects true protein content. The NPN and total nitrogen in chickpea are positively correlated[11]. A large variation in NPN would overestimate the true protein content of the sample and would consequently affect the estimated protein intake in the diet. Although genotypes exist with higher protein content no attempt has been made to combine high protein with high yield potential Efforts should be made to develop high protein genotypes since it has been reported that the amount of the protein content may be more than what was previously believed.

Although chickpea is a rich source of protein, quality is limited by sulphur containing amino acids, methionine and cysteine. It generally meets human adult requirement for all the essential amino acids, except methionine and cysteine. Next to sulphur amino acids are tryptophan, threonine and valine since the chemical score for these amino acids were generally below the satisfactorily level in several chickpea genotypes.

However, considerable variation may exist for this amino acid among the chickpea genotypes. Based on the amino acid consumption, the chickpea proteins were found to be of higher nutritive value as compared to other legumes.

**(2) Carbohydrates**

It is a good source of carbohydrate which together with protein influences the functional properties of chickpea flour and food production. Total seed carbohydrate varies from 52.4-70.9%[12]. Soluble sugars range from 4.80 to 8.5% kabuli types containing slightly higher amount than desi[11]. The bioavailability of carbohydrates is important in terms of calorific value; unfortunately the concentration of non-available

carbohydrates in chickpea is highest (25.6%) among commonly consumed pulses.

**(3) Lipids**

Among pulses chickpea contains highest amount of lipids, a large variation in fat content (3.8-10.2%) has been reported amongst chickpea genotypes. The fraction is high in unsaturated fatty acids, primarily linoleic and oleic acids. Due to this high content of essential fatty acids particularly linoleic and linolenic acids, the hypocholesterolmic effect of chick pea is high[13].

**(4) Minerals and Vitamins**

Chick pea is a good source of minerals and vitamins. Consumption of whole seeds of chickpea is desirable since its seed coat contributes about 70% of total seed calcium (190 mg/100 mg). It is high in phosphorous (340 mg/100g), magnesium (140mg/100g), iron (7mg/100mg) and zinc 3mg/100g. It contains a considerable amount of vitamin B1, B2, ascorbic acid and niacin. Its protein digestibility is highest in the dry edible legumes[14].

**(5) Dietary Fiber**

They are the remnants of plant cells, resistant to hydrolysis by human alienating enzymes, vary to a large extent among chickpea genotypes particularly between desi and kabuli genotypes Large variations in crude fiber content has been reported among the commonly grown cultivars .The concentration of dietary fiber is directly related to seed coat content and a large variability in the seed coat of chick pea cultivars has been reported. Dietary fiber content of kabuli genotype varies between 10.6 and 15.2% where as that of desi between 19.0 and 22.7[15].

This study further reported that cellulose and hemi cellulose accounted for about 60-70% of the total seed dietary fiber. Hemicelluloses accounted for about 55% of the dietary fiber whereas cellulose contributed about 10% in both desi and kabuli cultivars. Cellulose has been reported to be the least digestible component of dietary fiber whereas hemicelluloses produce a considerable amount of gas when ingested by human (El Faki et al, 1983). Kabuli cultivars have the best food technological qualities because of their lower content and thickness of seed coat suggesting that cultivars with reduced seed coat thickness would improve grain quality[16,17].

**Major Sources:**

Total Dietary fibre (TDF) content in food of plant source may vary. (Table 1)

**Table 1**: Major Sources of Total Dietary Fiber

| Source | Fiber % |
|---|---|
| **Cereal** | |
| Wheat grain | 16.9 |
| Wheat Bran | 47.1 |
| Oat bran | 17.2 |
| Barley | 19.1 |
| Jowar | 8.5 |
| **Legumes** | |
| Cow pea | 30.7 |
| Lima beans | 21.2 |
| Kidney beans | 23.3 |
| **Spices** | |
| Pepper | 27.8 |
| Coriander | 36.4 |
| Cumin | 23.1 |
| Fennel | 28.7 |
| Fenugreek | 33.5 |
| Red Chilli | 43.3 |

Source: Prosky et.al.[18]

**Medicinal Uses**

Medicinal applications include use for aphrodisiac, bronchitis, catarrh, catamenia, cholera, constipation, diarrhoea, dyspepsia, flatulence, snakebite, sunstroke, and warts. Acids are supposed to lower the blood cholesterol levels. Seeds are considered antibilious[19].

**Food Uses**

- Chick pea seeds are eaten fresh as green vegetable, parched, fried, roasted and boiled as snack. Seeds are ground and the flour can be used as soup, dhal, to make bread, or prepared with pepper, salt and lemon and served as a side dish[20].
- Sprouted seeds are added to salads. Young plants and green pods are eaten as leafy vegetable. Chickpea is canned and used in Turkey and Latin America to produce fermented food.
- Dhal is the split chickpea without the seed coat. It is dried and cooked into a thick soup or ground into flour for snacks and even sweet meats[20,21]. Animal feed is another use of chick pea in many developing countries. Green grain husks or green, dried stem and ears are used for stock feed. Whole seeds may be milled directly for feed.
- An adhesive may also be prepared from chickpea: although not water resistant. It is suitable for plywood.
- Leaves are said to yield an indigo like dye.
- Acid exudates from leaves can be applied medicinally or used as vinegar.
- In Chile cooked chick pea milk (4:1) mixture was good for feeding infants and was effective in controlling diarrhoea.
- Chick pea yields 21% starch suitable for textiles, giving a light finish to silk, wool and cotton cloth[19].

**Table 2**: Nutritional Composition of Chickpea

| Nutrients | Nutritive value of Chickpea/ 100g |
|---|---|
| 1. Moisture | 9.8g |
| 2. Protein | 17.1g |
| 3. Fat | 5.3 g |
| 4. Minerals | 3.0 g |
| 5. Fiber | 3.9g |
| 6. Carbohydrates | 60.9 g |
| 7. Energy | 360 Kcal |
| 8. Calcium | 202 mg |
| 9. Phosphorous | 312 mg |
| 10. Iron | 4.6 mg. |
| 11. Carotene | 189 mg |
| 12. Thiamine | 0.30mg |
| 13. Riboflavin | 0.15 mg |
| 14. Niacin | 2.9 mg |
| 15. Folic acid | 186.0 mg. |
| 16. Vitamin –C | 3 mg |
| 17. Choline | 194 mg |
| 18. Magnesium | 119 mg |
| 19. Sodium | 37.3 mg |
| 20. Potassium | 808 mg |
| 21 Zinc | 6.1 mg |

Source: Nutritive value of Indian foods[6]

**Significance of the Present Study**

Chickpea chosen for our study has many health benefits. It is a valuable source of proteins, carbohydrates, minerals, vitamins and is very high in dietary fiber. So it is a healthy source of carbohydrate for people with insulin sensitivity or diabetes. It contains 7.6 gm of dietary fiber. It is therefore planned to develop products using chickpea. The initiation of chickpea flour to substitute refined flour in the market products was because chickpea has many health benefits:

- Regular consumption may reduce risks of coronary heart diseases. They not only lower cholesterol, but the folate in this legume also lowers homocysteine levels. Homocysteine is a compound found in the body that in high concentrations is directly linked to heart disease. Magnesium is also vital for the heart. This mineral allows blood vessels to relax, which improves circulation, and increases oxygen and nutrient transport throughout the body.
- Preliminary evidences suggest that consumption of chickpea may be beneficial for correcting dyslipidemia.
- The fiber in chickpea helps to decrease blood cholesterol levels by binding bile acids in the small intestine and preventing re-absorption[47].
- Participants took part in a study to compare the effects of chickpea supplemented diet and that of a wheat supplemented diet on human serum The introduction of chickpea in the diet resulted in lower serum levels, total and low density lipoprotein and cholesterol levels.
- Chickpea is an important source of macro nutrients containing twice the amount of protein compared to cereal grains.
- In a study to determine the Glycemic Index of foods, it was concluded that chick pea have a low GI 28-32.
- Chick pea is an excellent source of essential trace element molybdenum. They are a very good source of fiber, folic acid, manganese and a good source of protein, as were as minerals such as iron, magnesium copper.
- Molybdenum is a trace mineral that helps to detoxify sulfites, compounds which are found in many prepared food products, dried fruits, and in wine. Some people are exquisitely sensitive to sulfites and develop headache, dizziness, rapid heart rate, and other unpleasant symptoms when they eat them, Sulfites can be difficult to completely avoid and the molybdenum found in chickpeas may help to offset some of the unpleasant symptoms.
- Chickpea also contains phytoestrogens which are weak plant versions of real oestrogen. There's evidence that these may modulate the body's own production of the hormone in a way that could lower the risk of breast cancer, protect against osteoporosis and minimize hot flushes in post menopausal women.
- Chickpea is an excellent source of soluble fiber. Being high in both soluble and insoluble fiber and with a low glycemic index, chickpeas can help people to feel fuller for longer, thereby helping appetite and manage weight control.
- It also contains fructo-oligosaccharides, a type of probiotics carbohydrate fiber, which supports healthy gut flora. Maintaining a healthy balance of friendly bacteria in the colon is necessary to optimize digestive function and strengthen immunity.

## OBJECTIVES

The objectives of the present study were:

- Bio-chemical estimation of various nutrients like moisture, ash, crude-fiber, protein, carbohydrate, fat, calcium, phosphorous, iron, zinc and folic acid in raw chickpea
- To study the effect of various types of processing like roasting, soaking and germination on the nutrient content of chickpea
- Development of value added products using raw chickpea and sensory evaluation of the developed products
- To analyze the obtained data statistically and draw conclusion

**Sensory Evaluation**

Sensory evaluation of food relies upon evaluation through the use of our senses (Odours, taste, texture, temperature, pain etc.). Only by applying exact scientific testing methods reproducible results can be obtained and analyzed statistically.

**Main applications of sensory evaluation are:**

1. Quality control of raw products, material and finished
2. Storage test
3. Analysis of competitive products
4. Development of value added product
5. Investigation of factors influencing the odour and flavour of the food, aroma, research market test and hedonic test

## LITERATURE SURVEY

From the beginning of time, man has been interested in food and its relationship to him. Poor man's "Meat" is a term used to describe pulses, or food grains that are grown in regions where the consumption of live stock products (animal protein) is limited. Pulses and legumes were amongst the earliest food crops to be cultivated by man[12]. Pulses belong to family Leguminosae and sub-family Papilionacea occupy the most demanding and essential place in Indian Agriculture System because of their valuable peculiar qualities. Pulses are important not only because of their high protein content which is three times as much as in cereals but also to their amino acid composition[4,5]. The amino acids in pulses have been found to be methionine, cysteine and tryptophan.

The crop chosen for the present study was chickpea (Cicer arietinum). Among food legumes, chick pea is a valuable source of proteins, carbohydrates, minerals and vitamins. It occupies an important place in human nutrition in many developing countries[19,22].

Chick pea is a highly nutritious crop. It is an important winter seed legume crop in Indo-Pakistan subcontinent. It contains about 22% protein[11]. It is fed to animals to obtain animal protein. It is the most important pulse crop in India, where it accounts for two, third of the world area and production[23]. Nutritional quality of raw chick pea seed has shown to contain 38-39% carbohydrate, 3% fiber, 4.8- 5.5% oil and 3% ash. The digestibility of protein varies from 76-78% and its carbohydrate from 57-60%.

Nutritional quality of chick pea (raw) as studied by Duke[10] stated that raw whole seeds contain per 100g:

357 Calories, 4.5-15.6% moisture, 14.9-24.6g protein, 8- 16.4g fat, 2.1-11.7g fiber, 2-4.8 g ash, 140-440 mg Ca, 190- 382 mg P. 5.0-23, 9 mg Fe, 0-225 mg b-carotene equivalent, 0.21-1.1 mg thiamine, 0.12-0.33 mg riboflavin, and 1.3-2.9 mg niacin. Further it was observed that boiled and roasted chick pea also contain similar amounts.

Sprouting is said to increase the proportionate amount of ascorbic acid, niacin, available iron, choline, tocopherol pantothenic acid, biotin, pyridoxine, inositol and vitamin-K. Malic acid and oxalic acid exudation from leaves may damage trousers and shoes. Wild species often have similar glandular secretions[10].

The amino acid composition of seeds with 19.5% protein: 5.5% oil (per 16g N) is: 7.2g lysine, 1.4g methionine, 8.8g arginine, 4.0g lysine, 2.3g histine, 4.4g isoluecine, 7.6g leucine, 6.6g. phenylalanine, 3.3g tyrosine, 3.5g threonine, 4.6g valine, 4.1g alanine, 11.7g aspartic acid, 16.0g glutamine, acid 6.0 g hydroxyl proline. 4.3g proline. The leaves contain 4-8% protein[9,10].

Shahid et.al. conducted a study on nutrition and composition of desi chick pea (Cicer arietnium L.) cultivars grown in Punjab, Pakistan. They found that potassium and manganese were noted as being present in higher and lower concentrations respectively. It was found that in these cultivars all the essential amino acids were present. Fatty acid profile indicated that saturated fatty acids were major fatty acids in all cultivars. The levels of some of the anti nutritional factors were also determined. The analysis should almost similar proportions of bio-chemical constituents among all cultivars. The data showed that in terms of quality and quantity. The desi chick pea cultivars can serve as a significant source of essential amino acids, essential fatty acids and trace minerals to meet the demand of population living in Punjab province of Pakistan.

Attia et.al., studied the effect of cooking on the physical properties, chemical composition and nutritive value of chick pea. Their findings were significant and marked losses in ash (34-40%), sugar (32-42%). oligosaccharide (30-34%) and anti nutritional factors content occurred on cooking the seed.

A study on the physio-chemical, nutritional and micro structural characteristics of chick pea following pressure cooking and microwave cooking was conducted by Marconi and associate. They found that the solid loss released in cooking water, were significantly less after microwave cooking than after conventional cooking (6.5 V/S 10.6g /100g of dry pea). They also concluded that in chick pea both types cooking methods increases the digestibility of protein and starches[24].

Khan and the group conducted a study on nutrition evaluation of desi and kabuli chickpeas commonly consumed in Pakistan. They concluded that the hydration capacity per seed of desi (0.16g) was lower than kabuli types (0.26g). The mean cooking time of dry desi and kabuli seed (124.5 V/S 113.8 minute) was reduced to 37.5 V/S 32.8 minute and to 28.8 V/S 22.5 minute, when soaked overnight. The mean value of protein (25.4V/S 24.4), fat (3.7 V/S 5.1%), carbohydrates (47.4 V/S 55%), crude fiber (11.2 V/S 3.9%), ash (3.2 V/s 2.8%) and caloric value (327 V/S 365 Kcal) per 100g were for desi/ kabuli chick peas respectively.

Onrakova and Menkor reported a study conducted on the moisture absorption characteristic of chick pea flour. In this moisture equilibrium data (adsorption and desorption) of chick pea flour were determined using static gravimetric method of saturated salt solution at 4° storage temp: 10, 20, 30, 40° C. The range of aw for each temperature was between 0.11 and 0.85. Equilibrium moisture content decreased with the increase in storage temperature at any given aw.

Khatoon and Prakash in 2006 conducted a study on the nutritional quality of microwave cooked and pressure cooked legumes. They found that the range of nutrient in 100g of cooked samples one as follows: moisture - 62.8 - 69.79%, protein- 14.7 - 24.3g; fat- 0.9 - 5.9 g, 1.7 - 4.6g. They also stated that the cooking methods did not affect the nutrient composition of chick pea, however altered the dietary fiber. in-vitro starch and protein digestibility of pressure cooked samples were higher than microwave cooked[24,25].

Saxena et.al. conducted a study on the nutrients and anti nutrients in chick pea cultivars after soaking and pressure cooking. Results show that soaking for 12 hours in distilled water decreased protein content from 22.4- 20.9% in different cultivars and pressure cooking at 15 lb/in² pressure for 15 and 30 minutes following soaking for 12 hours in distilled water results a further decrease in protein content[14].

Adawy conducted a study on the nutritional composition and anti nutritional factors of chick pea undergoing different cooking methods like boiling, autoclaving, microwave cooking and germination. He concluded that cooking treatments and germination caused significant decrease in fat, total ash, carbohydrate fractions, anti-nutritional factors, minerals and B-vitamins. Germination resulted in greater retention of all minerals and B- vitamins compared to cooking treatments. He also stated that microwave cooking appears to be the best alternative for legume preparation in house hold

purposes[26].

Niti et.al., in 2002 studied the effect of various home procuring methods on the nutritive quality of legumes. Results show that the decrease in total protein content was observed on germination, pressure cooking and frying but increases the digestibility, deduction in carbohydrate content by soaking and heat processing was also observed.

Total reducing sugar content was increased on soaking but cooking decreases it content.

Sharareh conducted a study on the effect of various processing conditions on nutritional qualities of legumes. She concluded that peas are a good source of complex carbohydrates, dietary fiber and protein are low in fat and sodium. She highlighted the importance of cooking method to improve textures palatability and digestibility of the legumes and also described some important methods of cooking like boiling, roasting, electric heating, microwave radiations, micronization and extrusion cooking. In the reference of cooking and soaking she concluded that flatulence effect of beans can be reduced by simply boiling them for a couple of minutes, soaking them for an hour in water and then changing water.

Removal of flatulence factors (galacto oligosaccharides) from chick pea (Cicer arietinum) by germination and mold fermentation was also studied. In this study the flatus producing factors and galacto oligosaccharides were identified in chick pea (Cicer arietinum var. Pant G-114) by descending paper chromatography. Four sugars galactose, sucrose, raffinose and stachyose were identified of which the latter two were galactose-containing sugar. Traditional methods like germination and fermentation by mold (Rhizopusoligosporus NRRL-2710) were employed to reduce galacto oligosaccharide level in seeds, while increasing its digestibility. Germination of seeds for 72 hrs. resulted in almost complete removal of galactose- containing sugars along with the accumulation of sucrose during early stages of germination[27].

Among the various methods available to reduce the plasma cholesterol, the most suitable would be the one involving a change in dietary regimens. Bengal gram (Cicerarietimum) which forms an important part of Indian diets has been reported to be more hypercholesterolemic than other pulses[28,29].

In another study the physico chemical, cooking, textural and roasting characters of chick pea was evaluated. Seeds of 5 desi (PBG-1, PDG-4, PDG-3, GL-769, GPF2) and one kabuli type (L-550) chick pea cvs. were evaluated for above properties. The results allowed that cultivars having higher seed weight and volume had higher cooking time, swelling and hydration capacity. The inter-relationships between cooking characteristics of seeds from different cvs. showed a significant negative correlation of puffing capacity, puffing index, expansion index with seed weight, volume, swelling and hydration capacity. The kabuli type chickpea cv. had poor roasting and textural properties. Cooking time had a positive correlation with hardness and gumminess and a negative correlation with springiness[30].

Adaway conducted a study on the effect of cooking treatment (boiling, auto-claving and microwave cooking) and germination on the nutritional composition and anti nutritional factors of chick pea. The results show that the cooking treatment and germination caused significant decrease in fat, total ash, carbohydrate fraction, anti- nutritional factor, minerals and vitamin-b group. Germination was less effective than cooking treatment in reducing anti nutritional factors. Based on these results microwave cooking appears to be the best alternative for legume preparation in household[26].

Another study conducted on effect of cooking on the protein quality of chick pea concluded that heat treatment produced a decrease of methionine, cysteine, lysine, arginine and tyrosine. The highest reductions being in cysteine (15%) and lysine (13.2%). Protein content declined by 3.4% and in vitro protein digestibility improved significantly from 71.8% 83.5%. After cooking the decrease of lysine was higher in the cooked chick pea seeds. The structural modification in globulin during heat treatment seems to be the reason for the increase in protein digestibility although the activity of proteolysis inhibitors in the albumin fractions was not reduced results suggests that appropriate heat treatment may improve the digestibility of chickpea protein.

Umaid Singh and associate studied the cooking quality and nutritional attributes of newly developed cultivars of chickpea and concluded that kabuli (cream seed coat) may be generally preferred to desi (brown seed coat) cultivars in terms of cooking time and sensory properties. Calcium content is noticeably higher in desi than in kabuli cultivars where as magnesium, iron, copper and zinc showed no definite trends. Levels of lysine, threonine, methionine and cysteine of these genotypes were within the range of FAO values. The biological value of protein was higher for kabuli than for desi although there was no difference in protein and amino acid of these varieties. Kabuli contained more utilizable protein and may be nutritionally better than desi.

Sood et.al., 2003 studied the effect of processing and cooking on the sugar content of chickpea cultivars HPG-17 and C-235. Different treatments like roasting, soaking germination, parching, pressure cooking and solar cooking were done and total reducing and non reducing sugars were estimated in both These sugars varied non-significantly with respect to various treatments. The sugar content was found to be more in HPG -17 than C-235 and HPG-17 was found to be better than C-235 variety.

A research on the grain quality concluded that the chickpea and pigeon pea are rich in protein but some anti nutritional factors reduced the absorption of nutrients. They can be reduced by simple heat treatments like pressure cooking and microwave cooking[11].

**Develop Products by Incorporating Chickpea**

Ahmed and associate conducted a research on the biochemical and sensory evaluation of carotene and protein enriched biscuits and found that addition of 18% chick pea flour/ pigeon pea flour to wheat flour biscuits increased the protein content from 10% in market biscuits to 13% in supplemented samples. Addition of carrot powder at 10% (Vitamin A content of 426 RE/100g) to flours incorporated for chick pea supplemented biscuits recorded best preference among people and were significantly (PO.05) better than pigeon pea biscuits. The essential amino acid lysine was significantly (PO.05) improved from 1.26g/100g protein in conventional market with to 3.39g/ 100g protein in chick pea biscuit which higher in vitro protein digestibility (95%) had compared to market biscuits (82.5). The calculated protein efficiency ratio of chick pea biscuits (1.6) was significantly (PO.05) higher than that of market biscuits (0.81).

Thakur and Modal in 2003 conducted a study to investigate the dehydration process of green nature 4D chick pea to use it as a snack food. Sample of green chick pea seeds as well as pods were blanched and dried. The dried chick pea seeds and pods were reconstituted within the range of 60-80 percent. The dehydrated chick pea seeds and pods were organoleptically analyzed for mastication. Studies shows that salt blended dried chick pea pods were preferred more to masticate than dried chick pea pods alone[31].

Ramaswamy and Susheesannia tried to experimentally study the effect of the concentration of butter made from chick pea (Cicer arietinum L) flour on the quality of a deep fried snack and concluded that boondi prepared with 40% solids in the batter had more desirable qualities such as uniformity, crispness and fried grain aroma. Those prepared from batters < 40% solids were more porous, oily and less uniform in shape and gave rise to tear drop shaped boondi. At >40% concentration of solid boondis were more firm and less porous with a slight sandy note although the fat content was low. Principal component analysis revealed that among the six commercial samples three samples were found to be close to optional quality while the other three were less satisfactory. Positive correlations were found for porosity, oily notes and fat content and negative correlations for firmness.

Pedrosillano and Sinoloa researched in 2006 on the effects of the chick pea variety on improving the nutritional value of bread and bakery products and concluded that legume flours, due to their amino acid composition and fiber content are ideal ingredients for improving the nutritional value of bread based bakery products. The influence of the total or partial replacement of wheat flour by chick pea flour on the quality characteristics of two kinds of cake was analysed. The effects of chick pea variety and the kind of flour used (white or whole) was also considered. Volume, symmetry, aroma, crust and crumb diminished on increasing the amount of chick pea flour. The replacement of wheat flour by chick pea flour also induced an increase in the initial firmness but cohesiveness and resistance diminished increasing the tendency to hardening.

Rababah and Ereify in their study evaluated the effectiveness of substituting different concentrations of chick pea, flour, broad, bean flour or isolated soy protein (ISP) on the physics chemical and sensory properties of biscuits. Results indicated that fortification decreased spread factor compared with the control. Sensory and instrumental color results showed that fortification with chickpea increased the lightness while fortification with broad bean or ISP increased the darkness. Descriptive results showed that as the fortified ISP and chick pea ratios increased most of liking area about right (JAR) attributes decreased, while they increased for fortified broad beans. Descriptive analysis also showed that 3% of fortified ISP and chick pea or 12% of broad bean provided the best quality ratio within each type of fortification. Consumer results showed that no significant differences of fortification of soy protein isolate (3%), chick pea (3%) or broad bean (12%) and the control. Sensory quality attributes of drinking and JAR were formed except for overall flavour and colour, fortification of chick pea and broad bean flour as well as ISP could be used in production of high protein biscuits[32].

Another study was conducted by Rababah and Ereify on the ability of chick pea flour to enrich pasta products (e.g., lasagne). On addition the influence of protein and other components upon the biological properties of the dough and the cooking quality of the wheat chick pea blends were determined. Supplementing lasagna with 5-20% W/W (weight/weight) chick pea flour improves the physical characteristics of dough which achieves optimum strength and extensible properties thus allowing the lasagna to maintain a firm and elastic form. Organoleptical properties (color, flavour and over all acceptability) improved with a low proportion of chick pea flour especially for 5% W/W substitution. So durum wheat can carry 5-10% (W/W) of chick pea flour and still meet the specification of pasta products in terms of firmness, cooking quality and sensory evaluation[32].

**Nutritional Reviews and Health Implications**

Regular intake of 40 g of chick pea has been shown to reduce low density lipoprotein cholesterol quickly. Geminated seeds are often recommended to prevent scurvy. Among the food legumes chick pea has the most hypo- cholesterolemic agent i.e. lowers blood cholesterol levels. Germinated chick pea was reported to be effective in controlling cholesterol level in rats[34,35].

Rababah and Ereify studied the improved effects of diets of chick peas on rats V/S cereal diet. Dyslipidemia and insulin resistance were examined. Chick pea treatment also induced a favourable plasma lipid profile reflecting decreasing TAG (total available glucose), LDL cholesterol (LDL-C), HDL-cholesterol levels (P<0.05). HFD (high fat diet) fed rats had higher TAG concentration in muscle and liver whereas the addition of chick pea to the HFD drastically lowered TAG concentration (muscle 39%, liver 23%). The activities of lipoprotein lipases (LPL) in eipdidynal adipose tyrosine and hepatic TAG bypass in liver recorded a 40% decrease and 23% increase respectively in HFD rats compared with those in NFD

rats. Dieting chick peas completely normalized the levels. Furthermore, chick pea- treated obese rats also showed a markedly lower lipids and <P< m RNA content in epididynal adipose tissue. An insulin tolerance test, oral glucose tolerance test showed that chick peas significantly improved insulin resistance and prevented postprandial hyper glycerin and hyper insulin induced by the chronic HFD. The present finding provides a rational basis for the consumption of chick peas as a functional food ingredient which may be beneficial for correcting dyslipidemia and preventing diabetes[33,34].

Chickpea are a valuable source of slowly digestible starch, which is beneficial to health as it results in relatively low post-meal blood glucose. Hawkins and Johnson studied the in vitro carbohydrate digestibility of whole-chickpea and chickpea products to determine levels of slowly digestible starch, rapidly digestible starch (RDS), resistant starch total starch and rapidly available glucose (RAG) of Whole chickpea and Chickpea products.

**Nutritional and Sensory Evaluation**

Most of nutritionists agree that on an average it is beneficial to plan daily intake fiber content of 30gm fiber on 12g/100Kcal by a normal healthy person. The proportion of soluble to insoluble fiber should be 1.2 and the intake is preferred to be through diet made up of varied sources preferred[18].

It is advisable to derive 50% each of the daily requirements from cereals, fruits and vegetables sources. For better effect American diabetes association (1994) has recommended 25/38g of fiber per day for person suffering from diabetes.

**Sensory Evaluation**

When the quality of food product is assessed by means of human sensory organs, the evaluation is said to be sensory of subjective or organoleptic. Every time food is eaten a judgment is made.

Sensory quality is a combination of different sense of perception combination into play in choosing and eating food. Appearance, flavour and mouth feel decides the acceptance of the food.

The effective characteristic is not a property of the food, but the subject's reaction to the sensory quality of foods. The reaction is highly conditioned by a variety of physiological and social factors and plays a vital role in the final analysis, in the acceptance and preference of the foods[27].

## MATERIALS AND METHODOLOGY

The present study was undertaken to analyze nutritional composition of chickpea, develop various chickpea products and evaluate acceptability of these products. The methodological aspects in which this study was conducted are as follows:

- Selection of samples
- Preparation of powder
- Bio-chemical estimation of nutrients in the selected samples
- Development of value added chickpea based products
- Sensory evaluation of the products
- Calculation of nutrients in the developed products
- Statistical analysis of the results

**Selection of Sample**

Selected chick pea seeds for experimentation were procured on the basis of variety (desi and kabuli) available in the market. Out of the two, desi type chickpea was selected for the present study. The chickpea was purchased from a general store in Jaipur. Chick pea comes under the food group of pulses and legumes which is a common food source for economically weaker section. The selected variety i.e. desi was divided into four groups:

Group I: Whole (raw)

Group II: Roasted

Group III: Soaked for 10hrs and germinated for 24 hrs.

Group IV: Soaked for 10 hrs and germinated for 48 hrs.

**Roasting**

Roasting was done in a wok at medium heat till the chickpea sample was light pink in color and gave a good aroma.

**Soaking**

Common household method for soaking was done. Chick pea samples were soaked for 10 hrs. at room temperature in aqua guard purified water.

**Germination**

The soaked samples were then germinated at room temperature with a variation in timing for 24 hrs. and 48 hrs.

**Drying**

The samples were dried in a hot oven at 80°C for 24 hrs and then taken for biochemical analysis.

**Preparation of the sample**

The dried chickpeas from all the groups were grinded to make a powder. 100 g of the powdered sample was passed through sieve (1.00-mm) and transferred to a well stopper glass bottle.

**Biochemical Estimation of Nutrients in the Selected Samples**

The aim of biochemical estimation was to evaluate altered state nutrients in the raw and processed chick pea sample by using the standard biochemical techniques. The quantitative analysis of protein, fat, ash, crude-fiber, moisture, carbohydrate, iron, phosphorous, calcium, zinc, folic acid sodium and potassium was done in accordance to Indian Standard Method Tests for Animal feeds and Food Stuffs.

**Development of Value Added Products and Standardization of Recipes**

By incorporating chickpea (raw) powder four products were developed. Khakra was developed using chickpea and wheat flour whereas other three products formulated using refined flour and chickpea flour were bread, pizza-base and bun. Different cooking methods were used; khakra was cooked on tawa while the others were baked.

The products were chosen keeping in mind the following reasons:

- Are highly popular among people of all age groups
- Have a good shelf life
- High palatability
- Easy to carry and store

Recipes were selected keeping in mind the target group i.e. all age groups. Due to change in life style people are consuming more of market based foods. These products are low in protein and fiber, high in carbohydrate and calories and are reported to be a major cause of life style diseases like obesity, diabetes, dyslipidemia and cardiovascular diseases.

**Market available products were coded as:**

1. Khakra A1
2. Bread B1
3. Pizza base C1
4. Bun D1

**The developed products were coded as:**

1. Khakra A2 (Wheat flour 60%, Chickpea Flour40%)
2. Bread B2 (Refined flour70%, Chickpea flour 30%), B3 (Wheat flour 30%, Refined flour 40%. Chickpea flour 30%)
3. Pizza base C2 (Refined flour 70%, Chickpea flour 30%), C3 (Wheat flour 30%, Refined flour 40%, Chickpea flour 30%)
4. Bun D2 (Refined flour 70%, Chickpea flour 30%), D3 (Wheat flour 30%, Refined flour 40%, Chickpea flour 30%)

**A. Khakra:** This product was developed by incorporating chickpea flour with wheat flour (Tables 3 and 4).

**Table 3**: Recipe: Basic-Ingredients

| Ingredients | Amount |
|---|---|
| Wheat flour | 100g |
| Salt | Pinch |
| Water | 30-40ml |
| Oil | 2.5ml |

**Table 4**: Recipe: Developed-Ingredients

| Ingredients | Amount |
|---|---|
| Wheat flour | 60g |
| Chickpea flour | 40g |
| Salt | Pinch |
| Water | 30-40ml |
| Oil | 2.5ml |

**Method**

- Oil and salt were added to wheat flour.
- It was kneaded into soft dough using water and rested for 5-10minutes.
- Then the dough was divided into small balls.
- With a rolling pin they were rolled on a board into very thin chapattis.
- Meanwhile a tawa was heated on gas burner.
- One of the rolled chapatti was then roasted on tawa till half done on medium flame.
- This chapatti was then removed from heat and cooled for 2 minutes.
- After cooling it was roasted again on very low flame till crisp.
- The other chapattis were made in the similar way.

**B. Bread:** Value added product was made using chickpea flour. Further variations were done in amount and type of flours. Wheat flour, refined flour and chickpea flour were used to make different breads (Table 5)

**Table 5**: Proportion of refined flour, wheat flour, and chickpea in developed products

| Products | Wheat flour | Refined flour | Chick pea |
|---|---|---|---|
| B2 | 70% (210g) | - | 30% (90g) |
| B3 | 40% (120g) | 30% (90g) | 30% (90g) |

**Table 6**: Recipe: Basic-Ingredients

| Ingredients | Amount |
|---|---|
| Refined flour | 300g |
| Sugar | 20g |
| Salt | 7g |
| Water | 210ml |
| Oil | 7g |
| Yeast | 7g |

**Method**

- In a vessel sugar, salt, yeast was dissolved in water.
- They were then mixed well in a food processor jar using a kneading blade
- To this refined flour was added.
- This mixture was kneaded in a food processor for 10-12 minutes with the oil being added little by little.
- The dough was then taken out from the processor, rolled and kept covered with moist cloth for fermentation till it doubled in volume.
- The kneaded flour was then rolled into a chapatti and its edges were folded.
- This was placed in a greased mould. On the upper surface slight marks were made with a knife and some oil was applied.
- Finally it was baked at 200°C for 40 minutes in a preheated oven and sliced after cooling.

**C. Pizza base:** This product using chickpea flour was developed and variations were done in proportion and type of flour (Table 7).

**Table 7**: Proportion of refined flour, wheat flour, and chickpea in developed pizza base

| Products | Refined flour | Wheat Flour | Chick flour pea |
|---|---|---|---|
| C2 | 70% (210g) | - | 30% (90g) |
| C3 | 40% (120g) | 30% (90g) | 30% (90g) |

**Table 8**: Recipe: Basic-Ingredients

| Ingredients | Amount |
|---|---|
| Maida | 300g |
| Sugar | 20g |
| Salt | 7g |
| Oil | 7g |
| Water | 215ml |
| Yeast | 7 g |

**Method**

- In a vessel sugar, salt and yeast were dissolved in water and mixed well in a food processor jar using a kneading blade.
- To this, refined flour was added and kneaded in the processor for 10-12 minutes, with the oil being added little by little.
- The dough was then taken out, rolled and kept covered with a moist cloth for fermentation till it doubled up in volume.
- Again it was kneaded lightly with hands and 15 balls were made.
- The balls were kept covered with moist cloth for 15 minutes.
- Meanwhile the electric oven was preheated at 200°Cand a baking tray was greased.
- On a rolling board with a rolling pin the balls were rolled into discs of diameter 5-6inches.
- They were then pricked with a fork, placed in the greased tray and baked in oven for 15-20 minutes till upper surface became slight pink in color.

**D. Bun:** Using chickpea flour value added product was developed. Then variations were done in amount and type of flour (Table 9).

**Table 9**: Proportion of refined flour, wheat flour, and chickpea in developed buns

| Products | Refined flour | Wheat Flour | Chick flour pea |
|---|---|---|---|
| D2 | 70% (210g) | - | 30% (90g) |
| D3 | 40% (120g) | 30% (90g) | 30% (90g) |

**Table 10**: Recipe: Basic-Ingredients

| Ingredients | Amount |
|---|---|
| Maida | 300g |
| Sugar | 20g |
| Salt | 7g |
| Oil | 7g |
| Water | 215ml |
| Yeast | 7g |

**Method:**

- Water was taken in a vessel and sugar, salt, yeast were dissolved in it. They were mixed well in a food processor jar using a kneading blade.
- Refined flour was added and kneaded in the processor for 10-12 minutes. Along with this oil was added little by little.
- The dough was then taken out, rolled and kept covered with a moist cloth for fermentation till it doubled in volume.
- A baking tray was greased and electric oven was preheated at 220°C for 10 minutes.
- Again the flour was kneaded lightly and balls were made.
- These balls were kept on the greased tray; some oil was applied on the upper surface and baked in oven at 220°C for 25-30minutes till the upper surface was brown in color.

**Sensory Evaluation of the Products**

Standardization of chickpea products were carried out through sensory evaluation. Sensory evaluation is concerned with the physical and chemical properties of the stimulus by the reaction it produces in humans acting as a measure apparatus. Chickpea products were evaluated for their sensory characteristics like colour, flavour, texture, taste, quality and overall acceptability by selected panel of judges.

The seven products formed were analyzed through sensory analysis and best products in each category were selected.

The panel was selected on the basis of threshold test. To check their perception for taste each of them were given 2 types of solutions to taste.

- Sugar solution (sucrose) prepared in 2 concentrations:

  0.4g and 0.6g/ 100 ml solution

- Salt solution (sodium chloride) in 2concentrations:

  0.08g and 0.15g / 100ml solution

Besides these solutions, each set had one glass of plain water. The panel members were given these solutions in a row in similar set of disposable glasses. They were then asked to compare the respectable concentrations in increasing order of sweetness or salinity and jot these observations in the score card given to them. Out of 10 members called to judge this threshold test 6 passed the test. Other factors like experience, knowledge, willingness, interest, availability and sincerity on the part of panel members were also considered. To evaluate the products made for the present study the six panel members which were enlisted (appendix) comprised of staff members of the International College for Girls, Jaipur.

For assessing the palatability and acceptability of chickpea products, score cards were developed on the basis of certain qualities generally looked for the in the product. These include color, flavour, taste, texture, acceptability (appendix). Three types of score cards were used:

1. Ranking test (for taste, colour, flavour, texture, quality)

2. Numerical scoring test

3. Hedonic scale test

The developed chickpea products were served to the judges separately in similar plates with different codes. Along with this necessary accessories were given to them to conduct the evaluation in an undisturbed environment. The objectives of the study were explained to the judges before the evaluation. All the panel members were asked to score the product on the basis of the given score cards. The mean scores for each of the sensory character as well as each of the products were calculated from the score cards in the form of percentage.

**Statistical Analysis**

The results of bio-chemical nutrient analysis and sensory evaluation were analyzed statistically by ANOVA (Analysis of Variance).

## Value Added Developed Products

**Figure 4:** Khakra (A2)

**Figure 5:** Bread (B2, B3)

**Figure 6:** Pizza base (C2, B3)

**Figure 7:** Bun (D2, D3)


**Figure 8:** A1 Khakra (Wheat flour), A2 Khakra (Wheat flour, chickpea flour)


**Figure 9:** Bread B1, (refined flour), B2 (refined flour chickpea flour), B3 (wheat flour, refined flour, chickpea flour)


**Figure 10:** Pizza base C1 (refined flour). C2 (refined flour, chickpea flour), C3 (wheat flour, refined flour chickpea flour)


**Figure 11:** BUN D1 (refined flour), D2 (refined flour, chickpea flour), D3 (wheat flour, refined flour, chickpea flour)

## RESULTS AND DISCUSSION

The objectives of the present study were:

- Nutrient analysis of whole (raw), roasted, soaked and germinated chick pea
- Development of new products using raw chick pea
- Sensory evaluation of the newly developed products by a panel of six judges
- Statistical analysis of the nutrient analysis and sensory evaluation by applying test ANOVA

Chickpea was subjected to various types of treatments, so it was divided into four groups.

Group-1: This group was analyzed raw for its nutrients.

Group-II: The chickpea in this group were roasted and nutrients analyzed.

Group-III: This group was soaked for 10 hrs. then germinated for 24 hrs and nutrients analyzed.

Group-IV: In this group chickpea were soaked for 10 hrs. germinated for 48 hrs and nutrients analyzed.

Bio-chemical analysis of nutrients was done according to Indian Standard Methods of Tests for Animal Feeds and Feeding Stuffs.

**Table 11** : Analysis of chickpea at different conditions

| Attributes | Whole (I) | Roasted (II) | Soaking 10 hrs Germination (24 hrs) (III) | Soaking 10 hrs Germination (48 hrs) (IV) |
|---|---|---|---|---|
| Moisture | 9.48% | 4.02% | - | - |
| Ash | 1.84% | 1.57% | 2.27% | 2.27% |
| Crude Fiber | 7.63% | 6.05% | 7.57% | 7.57% |
| Acid insoluble ash | 0.10% | 0.08% | 0.06% | 0.06% |
| Fat | 5.32% | 3.76% | 3.93% | 3.93% |
| Protein | 25.89% | 26.59% | 27.89% | 28.42% |
| Carbohydrate | 60.37% | 61.95% | 60.28% | 57.38% |
| Calcium | 0.45% | 0.47% | 0.45% | 0.45% |
| Phosphorous | 0.07% | 0.07% | 0.07% | 0.07% |
| Iron | 0.01% | 0.01% | 0.01% | 0.01% |
| Zinc | 0.01% | 0.01% | 0.01% | 0.01% |
| Folic Acid | 0.01% | 0.01% | 0.01% | 0.01% |

From the above table it is evident that Moisture content at 105°C was maximum i.e. 9.48% in group I and minimum in group II. This is due to the effect of roasting.

Ash at 600°C decreased from 1.84% in group I to 1.57% in group II. The reason may be attributed to the effect of roasting. Similar results are reported in studies by Allial et.al. (1999).

Crude fiber content found to be 7.63% was maximum in group I, followed by 7.57% in group III and 7.51% in group IV. With the advancement in time of germinating hours, crude fiber decreases. Soaking and germination have been reported to cause this decrease in similar studies by Badshah and Sattar (1991).

Acid insoluble ash was 0.01% in group I whereas it decreased to 0.08% in group IV. This is due to soaking and germination.

Fat content was found to be maximum in raw (group I) i.e. 5.32%.It decreased to 3.76% in roasted (group II), 3.93% in 24 hrs. germination (group III) and 3.99% in 48 hrs. germination (group IV). Roasting reduced the fat content to a greater extent in comparison to soaking and germination. Similar results are reported in studies by Adawy (2002).

Protein in group IV i.e. 28.42% was maximum and minimum in group I i.e. 25.89%. Similar results are reported in studies by Badshah and Sattar (1999). This marked increase may be due to activation of enzymes on soaking and germination and most of the enzymes are proteins.

Soaking and germination have caused a significant decrease in

carbohydrate content of chickpea from 60.37% in group I to 57.68% in group IV. The studies by Frias et.al. (1999) support this result.

There was a negligible decrease in the calcium content from 0.45% in group I, to 0.47% in group III and 0.48% in group IV. Phosphorous also showed a slight decrease from 0.07% in group I, II, III to 0.08% in IV .These results are similar to those reported in studies by Nestares et.al. (1999).

The effect of roasting, soaking and germination had no effect on the zinc content .It was 0.01% in all groups.

Iron and folic acid contents were same 0.01%in group I. II, III. There was a negligible change 0.04% for iron and 0.03% for folic acid in group IV.

New products like khakra, bread, pizza base and bun were developed using raw chickpea in comparison to already existing market products. These products were coded as:

Khakra - A2 (60%Wheat flour, 40% chickpea flour).

Bread - B2 (70% refined flour, 30% chickpea flour). B3 (40% refined flour, 30% wheat flour, 30% chickpea flour).

Pizza-base - C2 (70% refined flour, 30% chickpea flour). C3 (40% refined flour, 30% wheat flour, 30% chickpea flour).

Bun - D2 (70% refined flour, 30% chick flour), D3 (40% refined flour, 30% wheat flour, 30% chickpea flour).

Sensory evaluation of the newly developed products was done by a panel of six judges in terms of color, texture, taste, salt content, quality, overall acceptability, numerical scoring, difference of the developed products from the market products and nutrition composition. The scores given by the judges to the above performances were analyzed using ANOVA.

**Table 12**: Performance: Texture

| Code | Very good | Good | Fairly good | Fair |
|---|---|---|---|---|
| A 2 | - | 81.60% | - | - |
| B2 | - | 82.50% | - | - |
| B3 | 85.33% | - | - | - |
| C2 | - | - | 80.83% | - |
| C3 | - | - | 80.83% | - |
| D2 | - | 83.33% | - | - |
| D3 | 88% | - | - | - |

A2 - Wheat flour 60%, chickpea flour 40%
B2 - Wheat flour 70%, chickpea flour 30%
B3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
C2 - Wheat flour 70%, chickpea flour 30%
C3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
D2 - Wheat flour 70%, chickpea flour 30%
D3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%

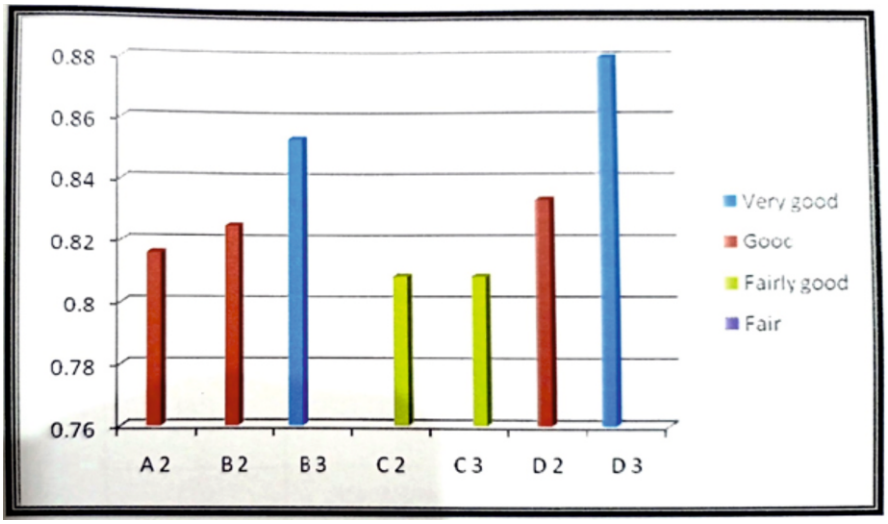


**Figure 12:** Texture Scores

For texture the scores of the judges were categorized as very good, good and fairly good:

| | | |
|---|---|---|
| Very good | - | 85-90% |
| Good | - | 80-85% |
| Fairly good | - | 75-80% |
| Fair | - | Below 75% |

The table 12 and figure 12 show that in terms of texture D2 scored highest 90% followed by B3 with 89.16% score. They were categorized as very good. D3 with 85% score.
A2 and B2 with 84.16% each were categorized as good. C2, C3 with 81.66% and 79.16% respectively were categorized as fairly good in texture. As the fiber content increases there occurs a change in texture still the developed products obtained good scores.

**Table 13 :** Performance: Quality

| Code | Superior | Equal | Inferior |
|---|---|---|---|
| A2 | 100% | - | - |
| B2 | 66.66% | 33.33% | - |
| B3 | 83.33% | 16.66% | - |
| C2 | 33.33% | 33.33% | 33.33% |
| C3 | 50% | 16.66% % | 33.33% |
| D2 | 83.33% | - | 16.66% |
| D3 | 100% | - | - |

A2 - Wheat flour 60%, chickpea flour 40%

B2 - Wheat flour 70%, chickpea flour 30%

B3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%

C2 - Wheat flour 70%, chickpea flour 30%

C3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%

D2 - Wheat flour 70%, chickpea flour 30%

D3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%

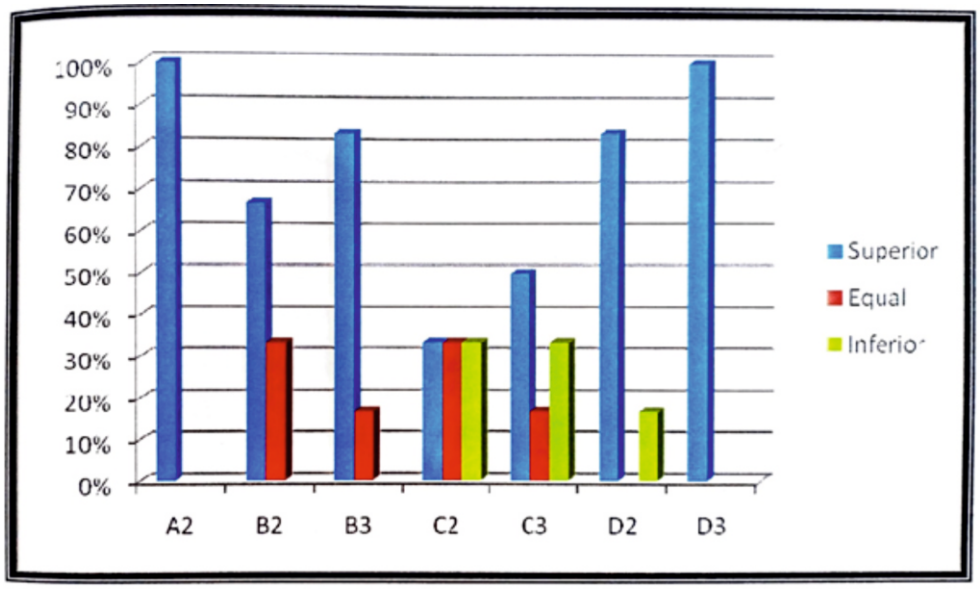


**Figure 13:** Quality Performance

The scores were graded into superior, equal and inferior as compared to their market counterparts (A - khakra, B - bread, C - pizza base and D - bun).
The table 13 and figure 13 indicate that A2 and D3 were found to be superior in quality by 100% judges. B2 was ranked superior by 66.66% judges while 33.33% stated it to be equal B3 was judged superior by 83.33% judges rest 16.66% graded it equal in quality.C2 was found to be superior by 33.33% judges. 33.33% said it was equal while the remaining 33.33% found it to be inferior.C3 was categorized superior by 50% judges, equal by 16.66% and inferior by 33.33%.D2 was grouped in superior category by 83.33% judges and inferior by 16.66% judges.

**Table 14:** Performance: Salt content

| Code | Optimum | Low | High |
|---|---|---|---|
| A2 | 100% | - | - |
| B2 | 33.33% | 66.66% | - |
| B3 | 33.33% | 66.66% | - |
| C2 | 50% | 50% | - |
| C3 | 33.33% | 67% | - |
| D2 | 66.66% | 33.33% | - |
| D3 | 83.33% | 16.66% | - |

A2 - Wheat flour 60%, chickpea flour 40%
B2 - Wheat flour 70%, chickpea flour 30%
B3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
C2 - Wheat flour 70%, chickpea flour 30%
C3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
D2 - Wheat flour 70%, chickpea flour 30%
D3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%

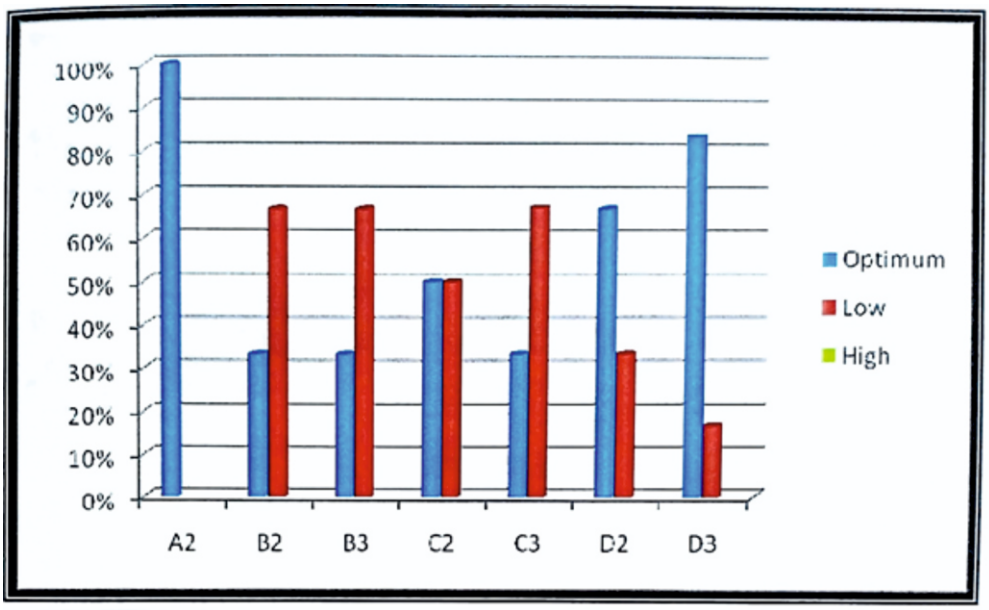


**Figure 14:** Comparative Assessment of Salt Content

Table 14 and figure 14 show that in case of A2 100% judges stated the salt content to be optimum. For B2 and B3, 66.66% judges found the salt content to be low whereas 33.33% found it to be optimum. In case of C2, 50% judges it was found to be low while the rest said it was optimum. Salt content in C3 was low for 67% judges whereas it was optimum for 33.33%. For D2 33.33% judges said it was low but 66.66% found it to be optimum. 83.33% judges said that in D3 it was optimum and only 16.66% reported it to be low.

**Table 15:** Performance: Colour

| Code | Very Good | Good | Not Good |
|---|---|---|---|
| A 2 | - | 83.33% | - |
| B2 | - | 80.33% | - |
| B3 | - | - | 66.66% |
| C2 | - | 83.33% | - |
| C3 | 90% | - | - |
| D2 | - | 84.16% | - |
| D3 | 89.16% | - | - |

A2 - Wheat flour 60%, chickpea flour 40%
B2 - Wheat flour 70%, chickpea flour 30%
B3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
C2 - Wheat flour 70%, chickpea flour 30%
C3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
D2 - Wheat flour 70%, chickpea flour 30%
D3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%

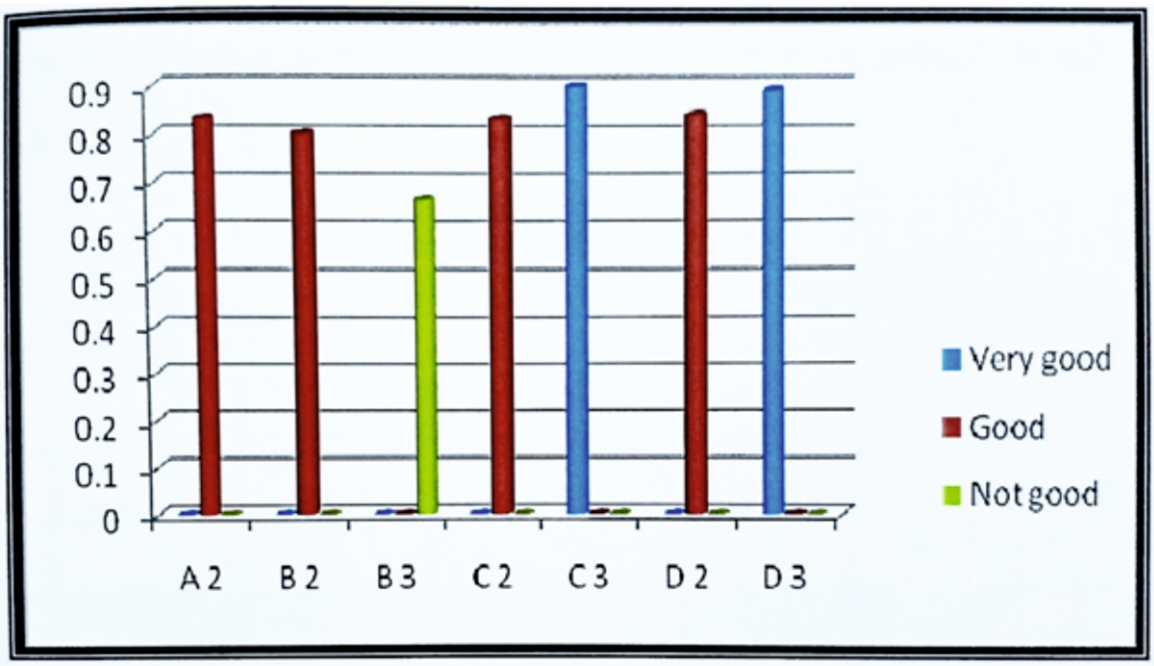


**Figure 15:** Colour Scoring

Color determines the quality of product at first step without even being tasted. Color was judged and scores were given. These scores were grouped into very good (85-90%), good (80-85%), not good (below 80%). Table 15 and figure 15 indicate that C3 scored 90% followed by D3 89.16% and were categorized as very good. A2, C2 with 83.33% score, B2 with 80.33% and D2 with 84.16% score were categorized as good.B3 was not good in color and scored lowest i.e., 66.66%.

**Table 16**: Overall acceptability of products on hedonic rating

| Code | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| A2 | - | 100% | - | - | - | - | - | - | - |
| B2 | - | 67% | 33.33% | - | - | - | - | - | - |
| B3 | - | 50% | 50% | - | - | | - | - | - |
| C2 | - | 16.67% | 66.66% | 16.67% | - | - | - | - | - |
| C3 | - | 50% | 16.67% | - | 33.33% | - | - | - | - |
| D2 | - | 33.33% | 16.67% | 16.67% | - | 16.67% | - | - | - |
| D3 | - | 33.33% | 50% | 16.67% | - | - | - | - | - |

A2 - Wheat flour 60%, chickpea flour 40%
B2 - Wheat flour 70%, chickpea flour 30%
B3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
C2 - Wheat flour 70%, chickpea flour 30%
C3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
D2 - Wheat flour 70%, chickpea flour 30%
D3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%

**Hedonic Scale:**
1- Like Extremely
2- Like very much
3- Like moderately
4- Like slightly
5- Neither like nor dislike
6- Dislike slightly
7- Dislike moderately
8- Dislike very much
9- Dislike extremely

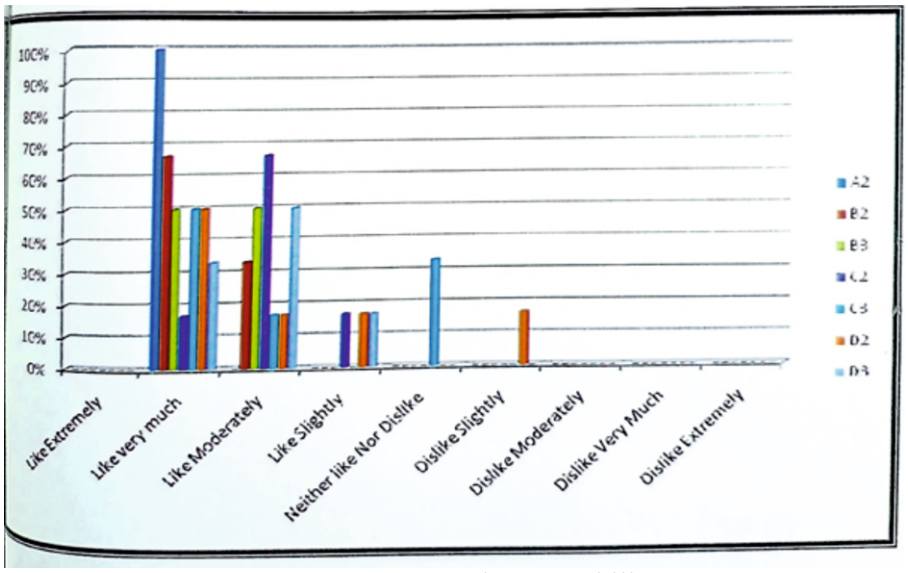


**Figure 16:** General Acceptability

General acceptability of any product is determined by the overall impression of sensory characters. The judges were asked to view the overall acceptability on hedonic scale. The results are depicted in the table 16 and figure 16. The table shows that the most acceptable product is A2 which was given hedonic rank 2 by all the judges. B2 was given hedonic rank 2 by 66.66% judges while 33.33% Judges gave hedonic rank 4 B3 was given rank 2 by 50% judges while the rest 50% grouped it in rank 4. C2 was given rank 2 by 16.66% judges while 66.66% judges gave rank 4.C3 was grouped in rank 2 by 16.66% judges but D2 scored hedonic rank 2 by 50% judges, 16.67% gave hedonic rank 3, 17% gave hedonic rank 4 and rest 16.67% grouped it in rank 5. D3 was given hedonic rank 3 by 50% judges.33% gave rank 2 and rest 16.66% gave rank 4.

**Table 17**: Difference of the developed product from the market product

| Code | Slight | Moderate | Large | Equal | None |
|---|---|---|---|---|---|
| A2 | 16.66% | 83.33% | - | - | - |
| B2 | 50% | - | 16.66% | - | 33.33% |
| B3 | 33.33% | 50% | - | - | 16.66% |
| C2 | 33.33% | 50% | - | - | 16.66% |
| C3 | 33.33% | 50% | 16.66% | - | - |
| D2 | 33.33% | 67% | - | - | - |
| D3 | 33.33% | 50% | 16.66% | - | - |

A2 - Wheat flour 60%, chickpea flour 40%
B2 - Wheat flour 70%, chickpea flour 30%
B3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
C2 - Wheat flour 70%, chickpea flour 30%
C3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
D2 - Wheat flour 70%, chickpea flour 30%
D3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%

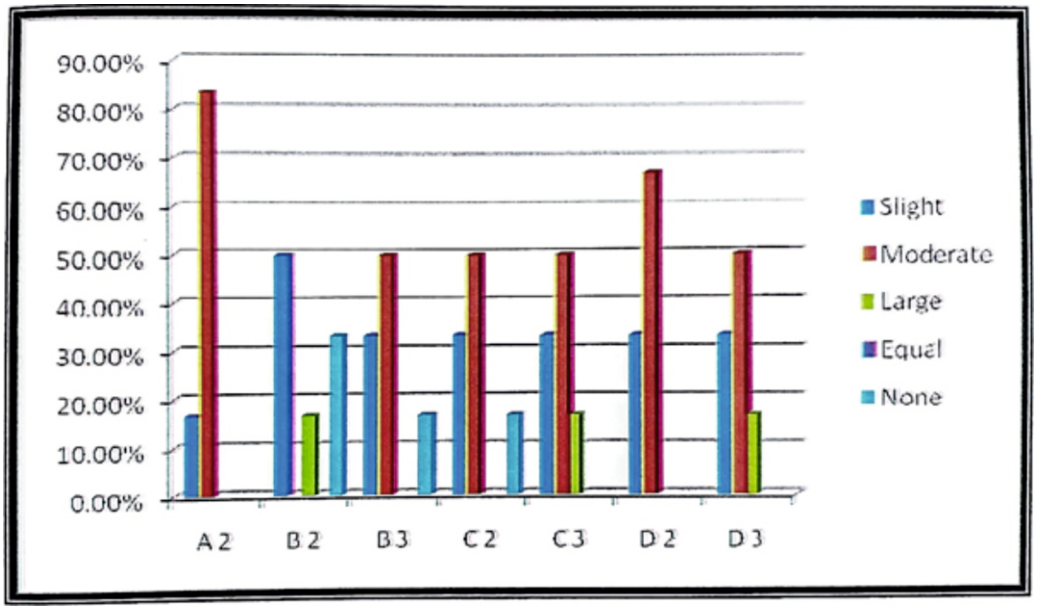


**Figure 17:** Comparison of Developed Product from Market Product

These developed products were then judged for their difference from the market products. (A - khakra, B - bread, C - pizza base, D - bun) as depicted in table 17 and figure 17. Sensory evaluation by the judges indicate that 16.67% judges graded A2 as superior to the market product and 83.33% said that there was a moderate difference from the market products. For B2 50% judges found a slight difference, 33.33% said there was no difference whereas 16.67% judges stated a large difference. B3 and C2 were judged and 33.33% found a slight difference, 50% found a moderate difference and 16.66% found no difference from their market counterparts.
In C3 and D3, 33.33% judges stated a slight difference, 50% said a moderate difference and 16.66% found no difference.
67% judges stated a moderate difference for D2 whereas 33.33% found a slight difference in the developed products.

**Table 18**: Numerical scoring of the developed product

| Code | Rank 1 | Rank 2 | Rank 3 | Rank 4 |
|---|---|---|---|---|
| A2 | 88.33% | - | - | - |
| B2 | - | 87.50% | - | - |
| B3 | 90.83% | - | - | - |
| C2 | - | - | - | 85% |
| C3 | - | 87.50% | - | - |
| D2 | - | - | 86.66% | - |
| D3 | - | - | 86.66% | - |

A2 - Wheat flour 60%, chickpea flour 40%
B2 - Wheat flour 70%, chickpea flour 30%
B3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
C2 - Wheat flour 70%, chickpea flour 30%
C3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%
D2 - Wheat flour 70%, chickpea flour 30%
D3 - Wheat flour 30%, refined flour 40%, chickpea flour 30%

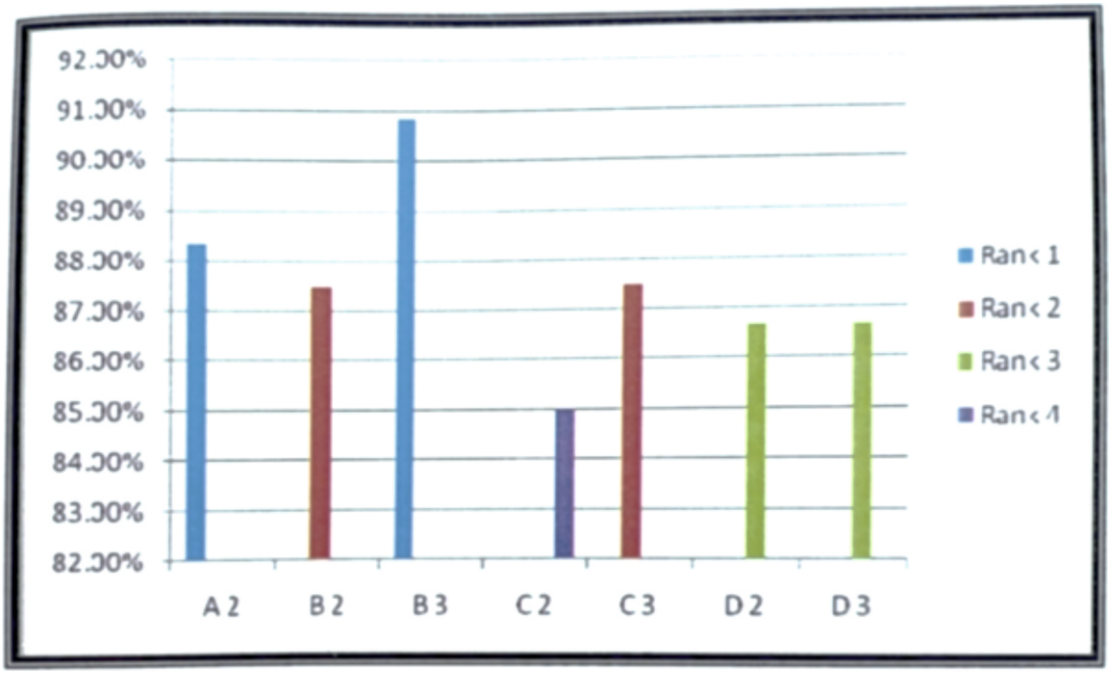


**Figure 18:** Ranking of Developed Product

Table 18 and figure 18 show that on comparing the developed products B3 scored 90.83% and was ranked 1st A2 scored 88.33% with rank 2nd, B2 and C3 ranked 3rd with 87.50% score each. D2 and D3 ranked 4th with 86.66% score whereas C2 scored least i.e., 85%. The low scores may be attributed to the incorporation of wheat and chickpea flour.

Statistical Analysis of the Results of Biochemical Analysis

Statistical Analysis was done on the data obtained. ANOVA (analysis of variances) was used for analysis (Table 19).

**Table 19**: Statistical analysis

| Attributes | Whole (I) | Roasted (II) | Germination (24 hrs) (III) | Germination (48 hrs) (IV) | GM | SE | SD 5% | CoV |
|---|---|---|---|---|---|---|---|---|
| Moisture | 9.47±0.0049 | 4.02±0.005 | - | - | 6.75±2.98 | 0.003 | 0.013 | 0.09 |
| Ash | 1.83±0.005 | 1.56±0.005 | 2.26±0.05 | 2.23±0.005 | 1.97+0.30 | 0.003 | 0.01 | 0.29 |
| Crude Fiber | 7.62±0.005 | 6.04±0.006 | 7.56±0.005 | 7.50±0.005 | 7.18±0.689 | 0.003 | 0.01 | 0.08 |
| Fat | 5.31±0.01 | 3.75±0.005 | 3.96±0.005 | 3.98±0.005 | 4.24±0.64 | 0.002 | 0.009 | 0.17 |
| Protein | 25.88±0.0076 | 26.58±0.006 | 27.89±0.007 | 28.41±0.005 | 27.19±1.03 | 0.0032 | 0.009 | 0.02 |
| Carbohydrate | 60.366±0.0133 | 61.94-0.0003 | 60.2750-0.0003 | 56.72±0.02 | 58.11±8.34 | 3.7501 | - | 12.91 |
| Calcium | 0.44 | 0.46±0.005 | 0.45±0.000 | 4.47±0.005 | 0.46±0.01 | 0.01 | 0.04 | 1.09 |
| Phosphorous | 0.06±0.005 | 0.07-0.00 | 0.06±0.005 | 0.08±0.00 | 0.07±0.006 | 0.0024 | 0.007 | 5.76 |
| Iron | 0.01±0.005 | 0.01±0.005 | 0.01±0.006 | 0.01±0.005 | 0.013±0.004 | 0.003 | 0.01 | 43.3 |
| Zinc | 0.01±0.005 | 0.01±0.005 | 0.01±0.005 | 0.01±0.005 | 0.013±0.004 | 0.003 | 0.01 | 43.3 |
| Folic Acid | 0.01±0.005 | 0.01±0.005 | 0.01±0.005 | 0.01±0.005 | 0.01±0.007 | 0.003 | 0.01 | 34.64 |

GM - General Mean

SE - Standard Error

SD 5% - Standard Deviation at 5%

CoV - Co efficient of Variance

The ANOVA for moisture revealed that moisture content in roasted sample is significantly less (4.03%) than the control (9.48%). The difference between treatments was significant.

The highest ash content observed in 10 hrs soaking 24 hr germination (group III) was 2.27% followed by 2.23% in 48 hr germination group (IV) then 1.83% in whole (group I) and 1.56% in roasted sample (group II). The difference between all treatments was significant.

Crude fiber was 7.62% in whole which was significantly higher than 7.56% in 24 hrs germination, 7.50% in 48 hrs germination and least in roasted. Difference between all the products was significant.

ANOVA on fat content revealed that fat was significantly higher 5.31% in whole (group I) than the other treatments which were 3.76%, 3.96%, 3.98% in roasted 24 hrs germination and 48 hrs germination showing significant difference between treatments.

Protein content analysis shows that it is significantly higher in

group IV (48 hrs germination) 28.49% respectively whereas it is low in other treatments Difference between all the treatments being significant.

Carbohydrate content is significantly higher in whole 60.36%, 61.94% in roasted and 24 hrs germination 60.27%, and56.72% in group IV revealing that difference between treatments was not significant.

ANOVA for calcium and phosphorous reveal that there is no significant difference for all treatments. There was no difference between the products for zinc, iron and folic acid.

**Statistical Analysis of Sensory Evaluation**

*Mean Values for Different Characters*

The analysis of variance reveals no significant difference between treatments for all characters. This indicates that numerical scoring of the products, color, texture, flavour, text, quality and overall acceptability of the products developed were at par to the market products.

Although there was no significant difference in the sensory evaluation of the developed products but the incorporation of wheat flour, chickpea flour in refined flour has increased the nutrient values.

**Nutrient analysis of developed products**

Nutrient Analysis of the prepared products was done in accordance with Nutritive Value of Indian Foods[36].

**Table 20**: Estimated nutrient content of market available (A) and developed khakra (A2)/ 100g

| Products | Protein | Fat | Carbohydrate | Energy | Crude Fiber |
|---|---|---|---|---|---|
| A | 12.1g | 1.7g | 69.4g | 391Kcal | 1.9g |
| A2 | 13.5g | 2.g | 66.7g | 381.7Kcal | 2.5g |

The above table gives a detailed account of protein, fat, carbohydrate, energy and crude fiber of khakra. The prepared product was good in nutritive values i.e. higher in protein and fiber, low in carbohydrate and energy as compared to standard. This was due to the high nutrient content of chickpea flour.
The market available products bread, pizza base and bun were taken as B, C and D.
The nutrient values of these market available products are given in the following table.

**Table 21**: Estimated nutrient content of market available products bread, pizza base and bun (B, C, D)/ 100g

| Products | Protein | Fat | Carbohydrate | Energy | Crude fiber |
|---|---|---|---|---|---|
| B/C/D | 7.8g | 63g | 51.9g | 245 Kcal | 0.2g |

Products B2, C2, D2 were prepared using 70% refined flour and 30% chickpea flour. The nutritive values are given in table/ 100 g

**Table 22**: Estimated nutrient content of Value added Products
Bread, pizza base, bun (Refined flour 70%, chickpea flour 30%)/ 100g

| Products | Protein | Fat | Carbohydrate | Energy | Crude fiber |
|---|---|---|---|---|---|
| B2/C2/D2 | 12.8g | 63g | 70.1g | 352 Kcal | 1.36g |

Products B3, C3, D3 were prepared using 40% refined flour, 30% wheat flour, 30% chick pea flour. The calculated nutritive values are as given in table.

**Table 23**: Estimated nutrient content of Value added products Bread, pizza base, bun (wheat flour 30%, refined flour 40%, chickpea 30%)/ 100 g

| Products | Protein | Fat | Carbohydrate | Energy | Crude fiber |
|---|---|---|---|---|---|
| B3/C3/D3 | 13.2g | 63g | 68.5 g | 349 Kcal | 1.8g |

The products B3/C3/D3 (bread, pizza base and bun) made using 40% wheat flour, 30% refined flour and chickpea flour 30% are nutritionally better due to high protein (13.2g), fiber (1.8g),carbohydrate (68.5g) and energy (349Kcal). B2, C2, D2 made of 70% refined flour and 30% chickpea flour have protein (12.8 g), crude fiber (1.35g), carbohydrate (70.1g) and energy (352.2 Kcal). The developed products A2, B3, C3 and D3 had more protein, fiber and low carbohydrate than the commercial products.

It may therefore be recommended that the use of these products instead of available products in daily life may be beneficial. This is because today people are consuming more of these market products in spite of the fact that they have low fiber and protein, but are rich in carbohydrate and calories. Fiber is particularly important in diet as lack of fiber causes obesity, constipation, diverticulous disease, cardio vascular diseases, diabetes etc.

The initiation of chickpea flour to substitute refined flour in the market products was because chickpea has many health benefits:

Heart disease: regular consumption may reduce risks of coronary heart diseases.

Dyslipidemia: Preliminary evidences suggest that consumption of chickpea may be beneficial for correcting dyslipidemia.

Cholesterol: The fiber in chickpea helps to decrease blood cholesterol levels by binding bile acids in the small intestine and preventing re-absorption. The introduction of chickpea in serum levels, total and low the diet resulted in lower density lipoprotein and cholesterol levels.

Protein: Chickpeas are an important source of macro nutrients containing twice the amount of protein compared to cereal grains.

Glycemic Index: In a study to determine the GI of foods, it was concluded that chick pea have a low GI 28-32.

Nutrients: Chick peas are an excellent source of essential trace element molybdenum. They are a very good source of fiber, folic acid, manganese and a good source of protein, as were as minerals such as iron, magnesium copper.

## SUMMARY AND CONCLUSION

The present investigation was done on chickpea. Chickpea (Cicer arietinum) chosen for this study is a pulse crop belonging to family Leguminosae and has many health benefits. It is a valuable source of proteins, carbohydrates, minerals, vitamins and very high in dietary fiber. Therefore it is a healthy source of carbohydrate for people with insulin sensitivity or diabetes. Out of the two varieties desi and kabuli, desi was chosen for investigation.

Nutrient content of raw chickpea/100g:

Moisture- 9.8 gm, Protein-17.1 gm, Fat- 5.3 gm, Carbohydrate-60.9 gm, Fiber-3.9 gm, Energy-360 Kcal, Calcium- 202 mg, Phosphorous- 312 mg, Iron- 4.6 mg, Folic acid- 186.0mg, Zinc- 6.1 mg.

This study was undertaken under following heads:

- Procurement of raw chickpea
- Bio-chemical analysis of chickpea
- Development of products
- Sensory evaluation of the developed products
- Statistical analysis of the results of biochemical analysis and sensory evaluation using ANOVA (Analysis Of Variance)
- Nutrient calculation of the developed products

Variety chosen for Chickpea was procured from market in Jaipur. For bio-chemical analysis it was divided into four groups:

Group I - It was analyzed raw

Group II - Chickpea was roasted and nutrients analyzed

Group III - This group was soaked for 10 hrs. and germinated for 24 hrs. and nutrients analyzed

Group IV- It was soaked for 10 hrs. germinated for 48 hrs. and then analyzed for nutrients

Group II, III, IV were dried in electric oven at 80°C for 24 hrs. They were cooled, grinded and sieved. The powdered chickpea was then stored in bottles with names of their respective groups and analyzed

Bio-chemical analysis was done in accordance to Indian Standard Method Tests for Animal feeds and Food Stuffs for moisture, ash, crude-fiber, protein, carbohydrate, fat, calcium, phosphorous, zinc, iron and folic acid

Raw chickpea powder was used to develop products available in the market

**Products were divided as:**

Market available products;

Product made by using refined flour and chickpea flour in the ratio 70:30;

Products made by using wheat flour, refined flour and chickpea flour in the ratio 30:40:30;

Khakra, bread, pizza-base and bun were developed using the basic recipe;

In case of khakra wheat flour and chickpea flour were used in the ratio 60:40

Sensory evaluation of the developed products was done by a panel of six judges. Judges were chosen on the basis of sensory evaluation test and comprised of staff of International College of Girls. For evaluation following types of score cards were given to the judges:

(a) Ranking scores cards for color, flavour (salt and sugar content), texture, taste, quality, hedonic rating, and difference from the market product.

(b) Numerical scoring of the products.

(c) Hedonic Scale Test

Bio-chemical estimations and results of sensory evaluation were statistically analyzed using ANOVA.

The results of bio-chemical analysis revealed that moisture content maximum in group I and minimum in group II decreased due to the effect of roasting.

Ash at 600°C was higher in group I than in group II. The reason may be attributed to the effect of roasting.

Crude fiber content found to be was maximum in group I. followed by group III and then group IV. With the advancement in time of germinating hours, crude fiber decreases.

Acid insoluble ash was more in group I whereas it decreased in group IV due to soaking and germination.

Fat content was found to be maximum in raw (group I). It decreased in roasted (group II) more as compared to in 24 hrs. germination (group III) 48 hrs. germination (group IV). Roasting reduced the fat content to a greater extent in comparison to soaking and germination.

Protein was maximum in group IV and minimum in group I. This marked increase may be due to activation of enzymes on soaking and germination and most of the enzymes are proteins.

Soaking and germination have caused a significant decrease in carbohydrate content of chickpea from group I to group IV. The difference between all the treatments was significant.

There was a negligible decrease in the calcium content from group I, in group III and then to group IV. Phosphorous also showed a slight decrease from group I, II, III to group IV.

The effect of roasting, soaking and germination had no effect on the zinc content .It was same in all groups.

Iron and folic acid contents were same group I, II, III. There was a negligible change for iron and folic acid in group IV. There difference was not significant.

The analysis of variance for sensory evaluation reveals no significant difference between treatments for all characters. This indicates that numerical scoring of the products, color, texture, flavour, texture; quality and overall acceptability of the products developed were at par to the market products.

Although there was no significant difference in the sensory evaluation of the developed products but the incorporation of wheat flour, chickpea flour in refined flour increased the nutrient values.

Nutrient Analysis of the prepared products was done in accordance with Nutritive Value of Indian Foods.

The prepared product khakra was good in nutritive values i.e. higher in protein and fiber, low in carbohydrate compared to standard. This was due to the high nutrient content of chickpea flour.

The market available products bread, pizza base and bun available in the market were taken as B, C and D.

The products B3, C3, D3 (bread, pizza base and bun) made using 30% wheat flour, 40% refined flour and chickpea flour 30% are nutritionally better due to high protein (13.2g), fiber(1.8g), carbohydrate (68.5g) and energy (349Kcal). B2, C2, D2 made of 70% refined flour and 30% chickpea flour had protein (12.8 g), crude fiber (1.35g), carbohydrate (70.1g) and energy (352.2 Kcal). The developed products A2, B3, C3 and D3 had more protein, fiber and low carbohydrate than the commercial products.

It is widely accepted that foods have many beneficial properties. It not only performs nutritional role but also is a powerful medicine. An effort was made to make high fiber products by incorporating chickpea flour, wheat flour and refined flour. On sensory evaluation these products were found to be same as market products.

Nutritionally the products made using wheat flour, refined flour and chickpea flour in the ratio 40:30:30 were better than the products made of refined flour and chickpea flour in the ratio 70:30. Therefore the use of these products is highly recommended.

It may therefore be recommended that the use of these products instead of available products in daily life may be beneficial. This is because today people are consuming more of these market products in spite of the fact that they have low fiber and protein, but are rich in carbohydrate and calories. Fiber is particularly important in diet as lack of fiber causes obesity, constipation, diverticulous disease, cardio vascular diseases, diabetes etc.

The initiation of chickpea flour to substitute refined flour in the market products was because chickpea has many health benefits:

1. Heart disease: regular consumption may reduce risks of coronary heart diseases.
2. Dyslipidemia: - Preliminary evidences suggest that consumption of chickpea may be beneficial for correcting dyslipidemia.
3. Cholesterol: The fiber in chickpea helps to decrease blood cholesterol levels by binding bile acids in the small intestine and preventing re-absorption. The introduction of chickpea in the diet resulted in lower serum levels, total and low density lipoprotein and cholesterol levels.
4. Protein: Chickpeas are an important source of macro nutrients containing twice the amount of protein compared to cereal grains.
5. Glycemic index: In a study to determine the GI of foods, it was concluded that chick pea have a low GI 28-32.
6. Nutrients: Chick peas are an excellent source of essential trace element molybdenum, also a very good source of fiber, folic acid and minerals such as iron, magnesium copper, and manganese.

**CONFLICT OF INTEREST: None**

**FINANCIAL SUPPORT: None**

**REFERENCES**

1. Mudambi S.R. Fundamentals of food, nutrition and diet therapy. New Age International private limited.2020 ISBN-13 978-8122433494
2. Williams P.G. Breakfast and the diet of Australian adults : An analysis of data from the 1995 National Nutritional Survey-2005
3. Ramakrishnan U.,Nguyen P. and Martorell R. Effect of micronutrients on growth of children under 5 years of age : meta-analysis of single and multiple nutrient interventions. Am.J.Clin.Nutri.2009;89(1) : 191-203
4. Swaminathan M. Handbook of food and nutrition. Bappco publication.1999, ASIN: B077JHRVON
5. The State of food and agriculture. FAO Agriculture Seva No.26, 1993. ISSN 0081-4539
6. Gopalan C., Ramshastri B.V. and Balasubramanium S.C. Nutritive Value of Indian Foods, National Institute of Nutrition, ICMR, Hyderabad, India.2012
7. Kupicha F.K. The delimitation of the tribe Vicieae (Leguminosae) and the relationship of Cicer L. Botanical Journal of the Linnean Society. 1997; 74 (2) :131-162
8. Hulse J.H. Nature, composition and utilization of food legumes. In: Muehlbaur, F.J., Kaiser W.J. (eds) Expanding the production and the use of cool season food legumes. Current Plant Science and Biotechnology in Agriculture, Vol.19. 1994. Springer. Dordrecht. . https://doi.org/10.1007/978-94-011-0798-3_3
9. 9.Huisman, J.,Van Der Poel, A.F.B. Aspects of the nutritional quality and use of cool season food legumes in animal feed. In: Muehlbauer, F.J., Kaiser, W.J. (eds) Expanding the production and the use of cool season food legumes. Current Plant Science and Biotechnology in Agriculture, Vol.19. 1994. Springer. Dordrecht. . https://doi.org/10.1007/978-94-011-0798-3_2
10. Duke, J.A. Handbook of Legumes of World Economic Importance. New York. 1981 http://dx.doi.org/10.1007/978-1-4684-8151-8
11. 11. Singh U. and Jambunathan R. Evaluation of rapid methods for the estimation of protein in chickpea (Cicer arietinum L.) Journal of the science of food and agriculture 1980. https://doi.org/10.1002/jsfa.2740310306
12. Sood, M., Malhotra S.R. and Kalia M. Effect of processing and cooking on sugar content of chickpea (Cicer arietinum) cultivars. Beverages and Food World 2003; 30 (12) :34-35
13. Sharma, R.D. An evaluation of hypocholesterolemic activities of some uncommon legumes. Nutr. Res. 1987; 7: 351-363
14. Saxena, A.K., Chadha, M. and Sharma, S. Nutrients and antinutrients in chickpea ( Cicer arietinum L.) cultivars after soaking and pressure cooking. J. Food Sci. Technol.2003; 40(5) :493-497
15. Singh, U., Subramanyam, N. And Kumar, J. Cooking quality and nutritional attributes of some newly developed cultivars of chickpea ( Cicer arietinum L.) J. Food Sci. Agric. 1991; 55: 37-46.
16. Muller, F.M. Cooking quality of pulses. J. Food Sci. Agric. 1967; 18:292-295.
17. Reyes-Moreno, K., Rouzand S., Carillo M. and Hernandez, C. Hard to cook tendency of chickpea ( Cicer arietinum L.) . J. Food Sci. Agric. 2001; 81(10): 1008-1012.
18. Prosky, L., Asp, N.G., Schweizer T.F. Devries J.W. and Fudra I. Determination of insoluble and soluble dietary fiber in foods and food products: collaborative study. J. AOAC International. 1992; 75 (2):360-367
19. Duke, J.A. Handbook of Legumes of World Economic Importance. Plenum Press, New York. 1981. http://dx.doi.org/10.1007/978-1-4684-8151-8
20. Saxena, S.K. and Craig J.G. Consumer cooperatives in a changing world. Annals of Public and Cooperative economics 1990. https://doi.org/10.1111/j.1467-8292.1990.tb01358.x
21. Hulse, J.H. (1994). Nature, composition, and utilization of food legumes. In: Muehlbauer, F.J., Kaiser, W.J. (eds) Expanding the Production and Use of Cool Season Food Legumes. Current Plant Science and Biotechnology in Agriculture, vol. 19. Springer, Dordrecht. https://doi.org/10.1007/978-94-011-0798-3_3
22. Singh, U. Nutritional quality of chickpea (Cicer arietinum L) current status and future research needs. Plant foods for human nutrition.1998; 35:339-351.
23. Kumar, V., Sinha A.K., Harinder, P.S. et.al. Dietary role of phytate and phytase in human nutrition: A review. Food Chemistry.2010; 120:945-959.
24. Khatoon, N. and Jamuna P. (2004) Nutritional Quality of Microwave-cooked and pressure cooked legumes. International Journal of Food Sciences and Nutrition. 55, 441-448.
25. Khatoon, N. and Jamuna P. (2006) Nutrient retention in microwave cooked germinated legumes. Journal of Food Chemistry. 97(1), 115-121.
26. Adawy, E.l. Nutritional composition and anti nutritional factors of chickpea (Cicer arietinum L.) undergoing different cooking methods and germination. Plant Food for Human Nutrition.2002; 57(1):83- 97.

27. Srilaxmi B. Food Science. New Age International publisher.2003 ISBN 8122414818,9788122414813

28. Mathur. K.S. Khan, M.A. Sharma, R.D. Hypocholesterolmic effect of Bengal gram. Brit. Med. J.1968;1: 30-31.

29. Soni.G.L, Molly.G., Singh.R. Role of some Indian pulses as hypocholesterolmic agents Ind.J. Nutr. Diet.1982; 19: 84-85.

30. Kaur M., Singh N. and Sodhi N.S. Physicochemical, cooking, textural and roasting characters of chickpea (Cicer arietinum L.) cultivars. Journal of Food Engineering2005; 69(4):511-517.

31. Thakur A.K and Modal, G. Dehydration of green chickpea seeds and pods. Indian Food Packer.2003; 57(1)64-67.

32. Rababah and Ereify, Faculty of Agriculture, Jordan Univ. of Science and Technology Jordan, 2003.

33. Menskin R.P. and Katan M.B. Effect of dietary fatty acids on serum lipids and lipoprotein. A meta-analysis of 27 trials. Arteriosclerosis and Thrombosis: A journal of Vascular Biology.1992; 12 (8):911-919.

34. Geeravani, P. (1991) Utilization of chickpea in India and scope for novel and alternative Uses. P. 47-54. In: Uses of Tropical Grain legumes: Proceedings of consultants meeting, 27-30 March 1989. ICRISAT Center, Patanchery, Andhra Pradesh, India.

35. Geeravani, P. and Theophilus .Effect of home processing on nutrient composition of certain high yielding legume varieties. Indian Journal Nutrition Dietetics.1980; 17: 443-446.