Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 8 Issue 12 December 2024

Review Article

Physico-chemical Properties, Nutritional Quality and Potential Utilization of Chickpeas: A Review

Baisali Bharadwaj Dash[1], Pallavi Gardia[2], Anushriya Sahoo[3] and Chandrashree Lenka*

[1]*Ph.D. Research Scholar, Department of Home Science, Rama Devi Women's University, Odisha, India*

[2]*Ph.D. Research Scholar, Department of Home Science, Rama Devi Women's University, Odisha, India*

[3]*Assistant Professor, Department of Home Science, Rama Devi Women's University, Odisha, India*

***Corresponding Author:** Chandrashree Lenka, Professor, Department of Home Science, Rama Devi Women's University, Odisha, India.

DOI: 10.31080/ASNH.2024.08.1464

Received: October 07, 2024

Published: November 08, 2024

Abstract

A recent trend has seen an increase in the number of people adopting a vegan diet. Therefore, plant-based protein sources are necessary to provide the dietary need for protein. Pulses comprise the main source of protein for vegetarians. The most extensively grown pulse crop worldwide is chickpea (Cicer arietinum L). The objective of the paper is to discuss the physical and chemical properties, nutrient composition, health benefits and various value added products made from chickpea. The information was collected mainly from secondary sources. The protein quality of chickpeas is thought to be superior to that of other pulses, and they are a rich source of both carbohydrates and protein. All of the necessary amino acids are present in significant concentrations in chickpea. The primary storage carbohydrate is starch, which is followed by dietary fibre. Although lipids are present in little amounts, chickpea is high in linoleic and oleic acid, two nutritionally significant unsaturated fatty acids. Thus, chickpeas can be used to create value-added food products which will serve as nutrient-dense food for low-income populations in developing nations and for those with lifestyle diseases.

Keywords: Chickpea; Physico-Chemical Properties; Nutrient Composition; Health Benefits; Value-Added Products

Introduction

One of the most commonly grown and eaten pulses in India is the chickpea (*Cicer arietinum*), popularly known as Bengal gram or Chana. For the people of India, it is one of the oldest, most significant, and common sources of protein. Chickpeas are the third most significant pulse crop farmed globally, after dry beans and peas, accounting for about 20% of global pulse production. 2016 has been designated as the International Year of Pulses, and this crop is receiving attention on a global scale. There are two types of chickpeas grown in the nation (Figure 1), namely

- **Desi:** Consumed in four different kinds (whole chickpeas, split gram, roasted gram, and flour), is dark brown in appearance, relatively small in size, and has a thicker seed coat.
- **Kabuli:** This whole seed has a whitish cream tint, is significantly larger in size, and has a thinner seed coat [30].

Chickpea, a Fabaceae plant, are true diploids (2 n = 2 x = 16) that are self-pollinated. It is a historically cultivated cool-season food legume crop that has been discovered in Middle Eastern archaeological sites that range from 7500 to 6800 BC. Due to its low production costs, wide range of adaptations, capacity to fix atmospheric nitrogen, ability to fit in many crop rotations, and presence of a prodigious tap root system, it is one of the most significant food legume plants in sustainable agricultural systems. Through its symbiotic relationship with Rhizobium, chickpea may fix atmospheric nitrogen up to 140 kg/ha. By incorporating organic matter for the maintenance of soil health and ecosystem, it also aids in improving the soil quality for the development of future cereal crops [33].

Due to the rise in health issues and chronic diseases, there has been a growth in the demand for nutrient dense foods as individuals place a greater emphasis on leading healthy lifestyles and eating a balanced diet. Vegan diets are gaining popularity day by day.

Today's research is more focused on sustaining plant-based nutrient supplies. Pulses comprise the main source of protein for vegetarians. The most extensively grown pulse crop worldwide is chickpea (*Cicer arietinum* L). It has several health advantages and is a great source of macro and micronutrients, including protein and dietary fiber. They are low in fat but a good source of essential fatty acids [16].

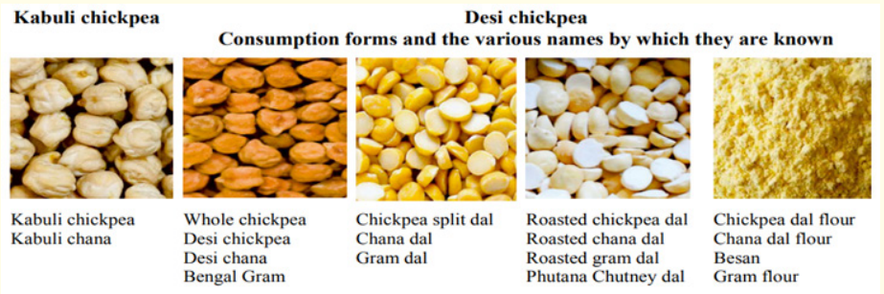

Figure 1: Various Forms and Names of Chickpeas.
Source: (Kumar et al., 2017).

Cultivation of chickpea

The three-month rabi crop (winter crop season) of chickpea is sown from the middle of October to the middle of December, and it is harvested from the middle of January to the middle of March. India accounts for 67% and 76%, respectively, of the global statistics for chickpea production and consumption. Madhya Pradesh (41%), Maharashtra (16%), Rajasthan (13%), Karnataka (8%) and Uttar Pradesh (6%), are the top producing states for chickpeas in India. It is grown as a winter crop in tropical areas and as a spring or summer crop in temperate areas [23].

Figure 2: Transition from Chickpea Plant to Chickpea Grains.
Source: (Grigorenko, 2017; Vkbhat, 2012; Kumar, 2018).

Significance of the Study

With this background the present study is designed to study the physicochemical properties, nutrient composition, health benefits and value-added products of chickpea to address global food and nutritional security.

Objectives

- To assess the physical and chemical properties of chickpeas.
- To study the nutrient composition of chickpeas.
- To discuss the various health benefits of chickpeas.
- To study different value-added products prepared from chickpeas.

Methodology

The present study was conducted by reviewing the available literature on the physical-chemical properties, nutrient content, health benefits and value added food products of chickpea. Information was collected from secondary sources like journals published between 2012 to 2023 using google scholar, PubMed, Science Direct and Research Gate and various websites. The journals were selected based on keywords, analysed, data was compiled and presented in the results and discussion section for interpretation. One limitation of the study is that all the data collected for the present study is taken form secondary sources only.

Results and Discussion

Physical-Chemical Properties of Chickpea

Table I shows the average values of various physical and chemical properties of chickpeas, compiled from various authors. The average values of length, width, thickness and sphericity of chickpeas ranged from 8.48 - 8.87 mm, 6.08 - 6.9 mm, 6.03 - 6.8 mm and 78 - 86.6 % respectively. There was not much difference in the aver-

Sl No.	Properties	Average Values	References
1	Length (mm)	8.48 - 8.87	Kumar and Sharma (2021)
2	Width (mm)	6.08 - 6.9	Laxmikanth., *et al*. (2020)
3	Thickness (mm)	6.03 - 6.8	Sinha., *et al*. (2019)
4	Sphericity (%)	78 - 86.6	Sastry., *et al*. (2013)
5	Moisture Content (%)	8.28 - 19.96	Kumar and Sharma (2021) Laxmikanth., *et al*. (2020) Ettoumi and Chibane (2014) Sastry., *et al*. (2013)
6	Geometric Mean Diameter (mm)	6.86 - 7.11	Kumar and Sharma (2021) Laxmikanth., *et al*. (2020) Sinha., *et al*. (2019)
7	1000 Seed Weight (g)	182.18 - 244.85	
8	Bulk Density (Kg/m^3)	680 - 881.49	Kumar and Sharma (2021) Laxmikanth., *et al*. (2020) Sastry., *et al*. (2013)
9	True Density (Kg/m^3)	865.30 - 1370	
10	Surface Area (mm^2)	148.08 - 173	Kumar and Sharma (2021) Sastry., *et al*. (2013)
11	Seed Coat Content (%)	9.6 ± 2.74	Sastry., *et al*. (2013)
12	Geographic Mean Diameter (mm)	7.4 ± 0.91	
13	Porosity (%)	49.6 ± 2.55	
14	Angle of Repose (Degree)	23.60	Laxmikanth., *et al*. (2020)
15	Roundness	0.78	
16	Ash (%)	2.45 ± 0.27	Ettoumi and Chibane (2014)
17	Foaming Capacity (%)	32.42 ± 1.97	
18	Foaming Stability (%)	46.10 ± 5.52	
19	Oil Absorption Capacity (g/g)	0.67	Solanke., *et al*. (2021)
20	Water Absorption Capacity (g/g)	2.21	

Table 1: Physical-Chemical Properties of Chickpea.

age values of length, width, thickness and sphericity reported by different researchers, they were similar. Moisture content ranged from 8.28 - 19.96 %. The minimum average value of moisture content i.e., 8.28 ± 0.24 % was reported by [6], who collected the chickpeas for analysis in July and August of 2012 from the Ain Defla region in Algeria. They reported that the low moisture content could be attributed to both post-harvest storage and climatic reasons. The maximum average value of moisture content i.e., 19.96 % was reported by [20], which may be due the humid climate of Raichur, Karnataka, India. Geometric Mean Diameter and 1000 Seed Weight ranged between 6.86 - 7.11 mm and 182.18 - 244.85 g respectively. Bulk Density, True Density and Surface Area ranged from 680 - 881.49 Kg/m3, 865.30 - 1370 Kg/m3 and 148.08 - 173 mm^2 respectively. Surface Area ranged between 148.08 - 173 mm^2. The average values of seed coat content, geographic mean diameter and porosity were reported to be 9.6 ± 2.74 %, 7.4 ± 0.91 mm and 49.6 ± 2.55 % respectively. The mean values of angle of repose and roundness were found to be 23.60 degree and 0.78 respectively. The ash content of chickpea was 2.45 ± 0.27 % and foaming capacity and foaming stability of chickpea flour was 32.42 ± 1.97 % and 46.10 ± 5.52% respectively. The oil absorption capacity and water absorption capacity of chickpea flour was found to be 0.67g/g and 2.21g/g respectively, which suggests that they could be used as functional ingredients in baked goods.

Nutrient composition of chickpea

Chickpeas contain 18 to 22% protein. Compared to other pulses, chickpeas have a higher protein content. It has a better protein efficiency ratio, protein digestibility, and biological value. Although it is a strong source of lysine and arginine, it is lacking in amino acids that include Sulphur. Carbohydrates make up the majority of chickpea seeds. Both readily available and inaccessible carbs are present. They include a lot of resistant starch and amylose. The main oligosaccharide in chickpeas is Ciceritol. Chickpea seeds have a 3-10% fat content. Linoleic acid is the predominant fatty acid in chickpeas, followed by oleic acid. Unsaturated fatty acids make up the majority of chickpeas fat content. Several micronutrients, primarily iron, calcium, zinc, and magnesium, are abundant in chickpeas. Zinc and iron requirements for a day can be satisfied by eating 100 g of chickpeas. A sizable amount of tocopherol (vitamin E) and

vitamin B complex are also present. The main phenolic components in chickpeas are isoflavones. The main carotenoids found in chickpea seeds are beta-carotene, xanthophyll, and cryptoxanthin [16]. The nutrient content of chickpeas is presented in table 2,3.

Nutrients	Chickpeas Dry*	Chickpeas Whole**	Nutrients	Chickpeas Dry*	Chickpeas Whole**
Macronutrients			**Vitamins**		
Energy (Kcal)	378	287.05	Vitamin C (mg)	4.0	-
Protein (g)	20.47	18.77 ± 0.42	Thiamin (mg)	0.477	0.37 ± 0.040
Fat (g)	6.04	5.11 ± 0.11	Riboflavin (mg)	0.212	0.24 ± 0.011
Carbohydrate (g)	62.95	39.56 ± 0.16	Niacin (mg)	1.541	2.10 ± 0.06
Fiber (g)	12.2	25.22 ± 0.39	Pantothenic Acid (mg)	1.588	2.38 ± 0.26
Sugar (g)	10.7	0.99 ± 0.16	Vitamin B6 (mg)	0.535	0.36 ± 0.025
Minerals			Folate (µg)	557	233 ± 12.9
Calcium (mg)	57	150 ± 18.3	Choline (mg)	99.3	-
Iron (mg)	4.31	6.78 ± 0.75	Vitamin A (IU)	67	-
Magnesium (mg)	79	160 ± 17.5	Vitamin K (µg)	9.0	2.10 ± 0.71
Phosphorus (mg)	252	267 ± 21.9	Vitamin E (mg)	0.82	1.72 ± 0.07
Potassium (mg)	718	935 ± 37.9	Lipids		
Sodium (mg)	24	26.56 ± 0.12	Saturated (g)	0.603	0.453
Zinc (mg)	2.76	3.37 ± 0.26	Monounsaturated (g)	1.377	0.89
Copper (mg)	0.656	0.85 ± 0.12	Polyunsaturated (g)	2.731	2.337
Manganese (mg)	21.306	2.71 ± 0.33			

Table 2: Nutrient Content of Chickpeas.

Source: *: Wallace., *et al*., (2016), **: IFCT NIN 2017.

Nutrients	Boiled Chickpeas*	Cooked Chickpeas**	Boiled Black Beans*	Boiled Lentils*
Calories (kcal)	164	164	132	116
Protein (g)	8.7	8.86	8.7	9.0
Carbohydrate (g)	27.4	27.42	23.7	20.1
Fat (g)	2.6	2.59	>1	0.4
Saturated Fat (g)	0.3	0.269	0.1	0.05
Calcium (mg)	49	49	27	19
Total fibre (g)	4.6	7.6	7.0	4.2
Iron (mg)	2.9	2.89	2.1	3.3
Magnesium (mg)	48	48	70	36
Phosphorus (mg)	366	168	140	180
Potassium (mg)	875	291	355	369
Sodium (mg)	7	7	1	2
Zinc (mg)	1.5	1.53	1.12	1.3
Dietary folate (g)	172	172	149	181
Copper (mg)	0.4	0.352	0.21	0.3
Selenium (g)	3.7	3.7	1.2	2.8

Table 3: Comparison Between the Nutritive Value of Boiled Pulses.

Source: *: Mudryj., *et al*., (2014), **: Wallace., *et al*., (2016).

Table 3 suggests that boiled chickpeas give more calories, carbohydrate, fat, calcium, iron, phosphorus, potassium, sodium, zinc, folate, copper and selenium, than boiled black beans and lentils. Boiled chickpeas provide same amount of protein as boiled black beans. Total fibre and magnesium content of boiled chickpeas is more than boiled lentils. The saturated fat content of all the boiled and cooked pulses is very low. Thus, boiled and cooked chickpeas can be considered as the vital pulses having low fat content with more protein content in comparison to others.

Type of Essential Amino Acid	Wheat Flour*	Chickpea Flour*	Chickpea Whole**
Leucine (g)	6.96	7.59	7.40 ± 0.31
Isoleucine (g)	4.25	4.76	4.34 ± 0.23
Lysine (g)	2.14	6.00	6.59 ± 0.25
Methionine (g)	2.00	1.54	1.16 ± 0.16
Cysteine (g)	1.33	1.36	1.27 ± 0.09
Phenylalanine (g)	4.48	5.57	6.26 ± 0.70
Tyrosine (g)	3.50	3.58	2.88 ± 0.15
Threonine (g)	2.60	3.86	3.55 ± 0.31
Valine (g)	4.94	5.60	4.58 ± 0.51
Total Essential Amino Acids (g)	32.20	39.89	38.03

Table 4: Comparison of Essential Amino Acid Content Between Wheat and Chickpea Flour and Whole Chickpeas.

Source: Rachwa-Rosiak., *et al*., (2015), **: IFCT NIN 2017.

Type of Non-Essential Amino Acid	Wheat Flour*	Chickpea Flour*	Chickpea Whole**
Alanine (g)	3.94	4.88	4.67 ± 0.56
Arginine (g)	3.61	7.82	8.59 ± 0.58
Aspartic Acid (g)	4.64	11.18	11.78 ± 1.60
Glutamic Acid (g)	26.59	18.05	17.27 ± 1.08
Glycine (g)	3.36	4.30	3.95 ± 0.16
Histidine (g)	2.45	2.96	2.51 ± 0.18
Proline (g)	8.11	4.68	3.74 ± 0.19
Serine (g)	3.85	4.77	5.10 ± 0.65
Total Non-Essential Amino Acids (g)	56.55	58.64	57.61

Table 5: Comparison of Non-Essential Amino Acid Content Between Wheat and Chickpea Flour and Whole Chickpeas.

Source: *: Rachwa-Rosiak., *et al*., (2015), **: IFCT NIN 2017.

Amino acid content is a crucial determinant of the nutritional value of food. Table IV and V showed that chickpea flour has significantly more non-essential amino acids (58.64 g/100 g protein) and essential amino acids (39.89 g/100 g protein) than wheat flour (32.20 and 56.55 g/100 g protein, respectively). Lysine, methionine, cysteine, and leucine are only a few of the necessary amino acids that are scarce in wheat flour. Methionine and cysteine, however, are the limiting amino acids in case of chickpea flour. Additionally, it was discovered that the proteins separated from chickpea flour have a looser arrangement, making them simpler to digest by our bodies. The total amino acids content of chickpea flour is 98.53 g/100 g of protein which is more than wheat flour i.e., 88.75 g/100 g of protein [29].

Table 4 showed that, whole chickpeas contained more lysine and phenylalanine than chickpeas flour, whereas chickpeas flour contained more leucine, isoleucine, methionine, cysteine, tyrosine, threonine and valine in comparison to whole chickpeas. Table 5 showed that, whole chickpeas contained more arginine, aspartic acid and serine than chickpeas flour, whereas chickpeas flour contained more alanine, glutamic acid, glycine, histidine and proline in comparison to whole chickpeas. So, it can be concluded that both total essential and non-essential amino acids content was more in case of chickpeas flour.

Type of Carbohydrate	Chickpea Grains*	Chickpea Whole**
Monosaccharides		
Ribose (g)	0.03 - 0.19	-
Fructose (g)	0.23 - 0.28	0.10 ± 0.01
Glucose (g)	0 - 0.065	0.10 ± 0.01
Disaccharides		
Sucrose (g)	1.09 - 2.28	0.69 ± 0.16
Maltose (g)	0.16 - 0.68	0.10 ± 0.01
Oligosaccharides		
Raffinose (g)	0.62 - 1.45	0.23 ± 0. 059
Ciceritol (g)	2.51 - 2.78	-
Stachyose (g)	0.74 - 2.56	0.58 ± 0.131
Verbascose (g)	0 - 0.19	-

Table 6: Carbohydrate Content of Chickpeas.

Source: *: Rachwa-Rosiak., *et al*., (2015), **: IFCT NIN 2017.

Table 6 compares the carbohydrate content of chickpeas reported by [29] with the values of IFCT given by NIN in 2017. High levels of monosaccharides, disaccharides, and oligosaccharides distinguish chickpea grains and flour from other grains and flours. The three main monosaccharides found in chickpeas are glucose, fructose, and ribose. Maltose and sucrose are two of the disaccharides' component parts. Raffinose, ciceritol, stachyose, and a trace quantity of verbascose are the primary oligosaccharides present in chickpeas [29]. Proteins and carbs, which combined make up roughly 80% of the dry seed mass of the chickpea, are good sources of energy. There have been reports of a range in the starch content of chickpea cultivars from 41% to 50%. More soluble sugars are present in the kabuli variety. The amount of unusable carbohydrates is larger in chickpeas than in other legumes, and the digestion of chickpea carbohydrates is lower than that of other pulses [13].

Figure 3 shows high concentrations of important unsaturated fatty acids, including linoleic, oleic, and linolenic acids, as well as to a small extent palmitic and stearic acids, are what constitute the fat in chickpea grains. Since linoleic acid is metabolised in bodily tissues where prostaglandins are produced, which lower blood pressure and control smooth muscle contraction, linoleic acid has significant nutritional benefit [29]. The typical fat content of chickpeas is higher than that of other pulse crops, ranging from 3.8 to 10.2%. Fatty acids in chickpeas are mostly derived from triglycerides and can be either saturated (have double bonds) or unsaturated (have no double bonds). 66% of the total fats found in chickpeas are PUFAs, followed by 19% MUFAs and 15% saturated fatty acids [22].

Health Benefits of Chickpea

- **Traditional Health and Medicinal Use:** In addition to being a good source of nutrients, chickpeas have historically been utilized for a number of medical and health-related uses. According to reports, chickpea seeds are tonic, aphrodisiac, expectorant, cooling, and helpful for hyperdipsia, leprosy, bronchitis, inflammations, and skin issues. For their anti-inflammatory qualities, the seeds were often applied as a paste to inflamed areas. Snakebites were also treated with chickpea flour that was cooked with hypericum. In Chile, newborns were given a cooked chickpea milk (4:1) mixture, which effectively controlled diarrhea [23].

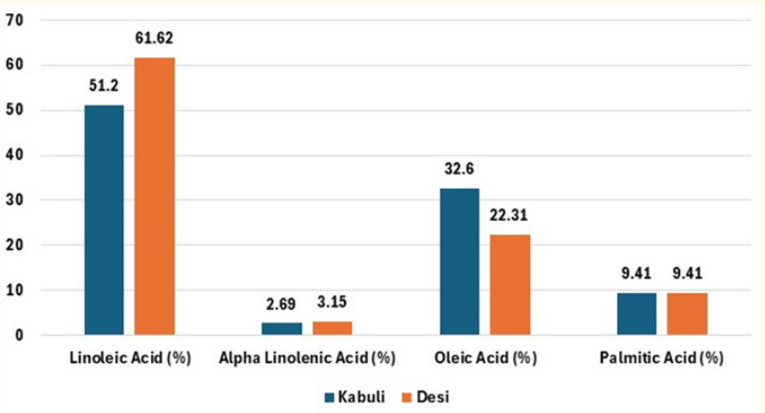

Figure 3: Comparison of Lipid Content between Desi and Kabuli Chickpeas. Source: Madurapperumage., et al., (2021).

- **Antimicrobial:** It has been discovered that chickpea seed extracts possess a number of antibacterial qualities. Against gram-negative organisms such Klebsiella pneumoniae, Escherichia coli, and Pseudomonas aeruginosa, it has demonstrated a variety of antibacterial actions. It exhibits antibacterial activity against Enterococcus faecalis among gram-positive bacteria. Additionally, it has been claimed that chickpea lectin exhibits antifungal action, exhibiting 85% growth inhibition in Candida krusei and 81% in Fusarium oxysporum. Additionally, it has been discovered to inhibit Candida albicans and Saccharomyces cerevisiae. On HIV-1 reverse transcriptase, a number of chickpea seed extract ingredients, including cicerarin and other peptides, have similarly demonstrated an inhibiting impact [7]; [1].
- **Antioxidant:** Chickpea seed coat extracts have the strongest antioxidant properties. It has been demonstrated that adding 5-20% chickpea flour to raw pasta increases its antioxidant capabilities by doubling the amounts of p-hydroxybenzoic acid and ferulic acid [5]; [1]; [10]
- **Anti-Inflammatory:** PGE2 (lipid, prostaglandin hormone secreted by the walls of blood vessels in reaction to an inflammation or infection) production was shown to be significantly reduced by desi chickpea extracts when compared to reactions without the extract, by more than 85%. Compared to albino rats not given chickpeas, those fed methanol extract of C. arietinum (200 and 400 mg/kg dosages) had much less paw oedema. It might be brought on by serotonin, prostaglandin, or histamine inhibition [38]; [1]; [10].
- **Prebiotic Potential:** Studies on ciceritol, one of the main oligosaccharides in chickpeas, have shown that it inhibits the growth of Bacteroides while promoting the growth of Enterococcus, Lactobacillus, and Bifidobacterium. Additionally, it was discovered to have a higher concentration of proximal colon crypt mucus than the basal diet, which protects the epithelial cell surface by acting as a physiochemical barrier. Chickpea significantly decreased cecal luminal pH, which is a biological change in the gut environment that has been shown to reduce the growth of harmful microbes and enhance nutritional uptake [24].
- **Weight Loss:** A safe, affordable, and natural alternative to pharmaceutical obesity medications is chickpea. Male rats that were obese were given chickpea combined with a high-fat meal, and less weight gain was observed as compared to the control group that received only the high-fat diet. Chickpea contains a significant amount of protein and fibre, which reduces feelings of hunger and a desire for food, reducing the intake of unhealthy foods and the problem of weight gain [27].
- **Hypercholesterolemia:** A minor but significant increase in dietary fiber and poly-unsaturated fatty acids (PUFA) was seen when chickpeas were added to the usual ad libitum diet of 45 healthy people between the ages of 30 and 70. Another study demonstrated that the peptide Cpe-III, which is derived from chickpeas, lowers hyperlipidemia by reducing the build-up of total cholesterol and triglycerides in the liver and serum of male Kunming mice fed a high-fat diet [39]; [27]; [1].
- **Diabetes:** The glycemic control-improving effects of chickpea are attributed to an insulin-saving mechanism. It has been proven that substituting half a serving of chickpeas per day for similar amounts of rice, eggs, bread, or baked potatoes lowers the risk of developing diabetes. Low glycemic index foods like chickpeas have lowered postprandial glycemic reactions. Studies have shown that chickpea's high protein and dietary fibre content, as well as mechanical preparation, had no effect on the postprandial glycemic response to chickpea. [4]; [10]; [1].
- **Cancer:** Cancer cell lines have been demonstrated to be inhibited by chickpea extracts in a dose-dependent manner. It was discovered that chickpea protease inhibitor significantly inhibited LNCaP prostate cancer cells in comparison to other PICs in a study on seven different protease inhibitor concentrates (PICs), including kidney bean, linseed, soybean, chickpea, green gram, peas, and lentils. Additionally, chickpeas

have concentrated hydrophobic, apolar proteins that prevent the growth of epithelial tumours without having any negative effects on the non-transformed epithelium [10]; [7]; [1].

- **Hypertension:** Given that chickpea proteins are proved to be a good source of bioactive peptides with ACE inhibitory activity, chickpeas may play a critical role in regulating hypertension. Chickpea desi varieties' protein hydrolysate has demonstrated greater ACE inhibition [11].

Value added products made from chickpea

Table 8 shows various value-added food products made from chickpeas along with their nutritional potentials.

- The entrapment and gastrointestinal transport of flaxseed oil was successfully accomplished by the use of microcapsules made of chickpea protein isolate and lentil protein isolate [15].

Bioactive Compounds	Functions	References
Carotenoids	β-carotene is one of the most significant carotenoids in chickpea. It is the best carotenoid for converting into vitamin A.	Kaur and Prasad, 2021 Acevedo Martinez., *et al*., 2021
Isoflavones - biochanin A	They have demonstrated anti-inflammatory, anti-cancer, anti-antioxidant, and anti-diabetic activities. Has the ability to boost catalase and superoxide dismutase while lowering oxidative stress.	Gupta et al. 2018 Acevedo Martinez., *et al*., 2021
Lectins	Have hemagglutinating properties. Have shown anticancer properties. Effectively inhibits α-glucosidase and α-amylase. Exhibit antifungal action.	Gautam., *et al*., 2018 Gupta., *et al*., 2018 Acevedo Martinez., *et al*., 2021
Phenolic acids - Gallic acid	Second most prevalent phenolic acid in chickpeas. Has been demonstrated to have antiviral, antibacterial, and anticarcinogenic activities. Targets reactive oxygen species.	Acevedo Martinez., *et al*., 2021
Phytic acid	Amylase is inhibited, which improves colon health by lowering blood sugar levels. It plays a role in slowing down the calcification process, which prevents kidney stone development.	Acevedo Martinez., *et al*., 2021
Saponin	Despite being antinutritional substances, have antioxidant properties when they bind to cholesterol. By doing this, both humans and animals plasma cholesterol levels are reduced and oxidative damage is prevented.	O'Neil., *et al*., 2014 Acevedo Martinez., *et al*., 2021

Table 7: Bioactive Compounds of Chickpea and Their Functions.

- Incorporating more chickpea flour into spaghetti pasta decreased the ideal cooking time, decreased water absorption, increased adhesiveness, increased their protein, mineral, fat, and dietary fibre levels. As the amount of chickpea flour was increased, the glycemic index of the enriched spaghetti samples reduced [28].
- Capsules of folate was made with a protein that was extracted from chickpeas. When folic acid is coated with chickpea protein, it becomes a multi-nutritious material that also adds value to food products [3].
- By blending cooked, mashed chickpeas with tahini, olive oil, lemon juice, and seasonings, traditional hummus is made which is a nutrient-rich dip or spread. Recent studies indicate that chickpeas and hummus may be helpful in controlling weight, regulating glucose and insulin, and improving several markers of cardiovascular disease [37].
- Chickpea flour and xanthan gum were completely substituted for wheat flour in muffin formulations, either alone (at 0.5 and 1%) or in combination with inulin or whey protein. Chickpea flour-based muffins with added xanthan gum alone had greater cohesiveness, wetness, sponginess, and springiness scores and were easier to swallow [12].
- The thick liquid left over after cooking chickpeas in water is known as aquafaba which is egg substitute. Aquafaba-based cakes were less cohesive and springy than egg-white-based cakes [26].
- The PDCAAS (Protein Digestibility-Corrected Amino Acid Score) of the loaves with chickpea supplements was improved due to larger concentrations of limiting amino acid lysine. The dietary selenium levels, protein content, and cellular antioxidant activity were all improved by 15% selenium germinated chickpea flour added to wheat flour [9].

- When compared to rice flour, snacks created showed a considerable increase in protein, fiber, ash, carbohydrate content, and calorific value while a decrease in fat content due to the use of chickpea flour [2].
- Chickpeas and coconut-based milk showed a stronger nutritional composition, including protein, calcium, and lipid content compared to cow's milk and other popular alternatives. Plant-based milk with 70% chickpea extract and 30% coconut extract with 0.3% vanilla extract may be a suitable substitute for cow's milk [31].
- Probiotic cultures and chickpea flour bio-yoghurts increased probiotic bacterial growth and viscosity. The antioxidant capacity of stirred bio-yoghurt supplemented with chickpea flour was higher than that of the control, which was lower [14].

Product	Function	References
Encapsulation of Flaxseed Oil	High efficiency of encapsulation. Effective for entrapping and delivering flaxseed oil through the digestive system.	Karaca., *et al*., 2013
Pasta	Optimal cooking time is reduced. Water absorption decreases. Adhesiveness is increased. Reduction in glycemic index.	Padalino., *et al*., 2014
Encapsulation of Folate	Boost the stability and potency of food. protection against folate deterioration due to heat. Folic acid is released in control for pharmaceutical uses.	Ariyarathna and Karunaratne, 2015
Hummus	Increases intake of nutrients. Helpful in controlling weight. Regulates glucose and insulin. Improves several markers of cardiovascular disease. Bowel health is improved.	Wallace., *et al*., 2016
Muffins	Batter viscoelasticity is increased. Starch gelatinization temperature id delayed. Sensory quality is enhanced.	Herranz., *et al*., 2016
Sponge Cake (Aquafaba)	A plant-based emulsifier. Potential substitute for eggs in cake and mayonnaise.	Mustafa., *et al*., 2018
Bread	Improves selenium levels, protein content, and cellular antioxidant activity. Increases protein digestibility.	Guardado-Félix., *et al*., 2020
Ready To Eat Snacks	Protein digestibility is improved. Soluble fibre content increases.	Altaf., *et al*., 2020
Chickpea and Coconut Based Milk	Increases protein, calcium, and lipid content. Has the potential to substitute cow's milk.	Rincon., *et al*., 2020
Yogurt	Viability of probiotic bacteria increases. Total phenolic content increases. Viscosity increases.	Hussein., *et al*., 2020

Table 8: Value Added Products Made from Chickpea.

Conclusion

Due to the great nutritional value of chickpeas, particularly their high protein level, they are known as the poor man's meat. As a cheap source of protein, carbohydrates, unsaturated fatty acids, vitamins, minerals, and bioactive substances, chickpeas are a significant pulse crop. Due to its numerous health advantages, including weight loss, type 2 diabetes prevention, cholesterol control, and anti-cancerous activity, chickpea is becoming more and more popular as a functional food. It has a low glycemic index and is a good source of nutritional fiber. The promise of achieving food security is presented by chickpeas, which can also serve as a viable supply of plant-based protein. It may prove to be beneficial in overcoming protein-energy deficiency. Products free of gluten that are good for celiac disease patients can be made from chickpea. Chickpeas can contribute to balanced nutrition when added to foods made from cereal. Despite the fact that chickpea consumption

has been steadily rising, it is still important to spread awareness among the parents, especially mothers in rural areas to address the problems related to malnutrition among children and control lifestyle disorders adults and young generations.

Future Prospects

- Chickpea extracts should be studied in order to create secure and affordable replacements for the medications currently prescribed for various disorders.
- The potential of chickpea prebiotics in curing diseases and comprehending their fundamental underlying mechanisms require further study.

Bibliography

1. Acevedo Martinez KA., *et al*. "Technological properties of chickpea (cicer arietinum): Production of snacks and health benefits related to type-2 diabetes". *Comprehensive Reviews in Food Science and Food Safety* 20.4 (2021): 3762-3787.

2. Altaf U., *et al*. "Investigation on mild extrusion cooking for development of snacks using rice and chickpea flour blends". *Journal of Food Science and Technology* 58.3 (2020): 1143-1155.

3. Ariyarathna IR and Nedra Karunaratne D. "Use of chickpea protein for encapsulation of folate to enhance nutritional potency and stability". *Food and Bioproducts Processing* 95 (2015): 76-82.

4. Becerra-Tomás N., *et al*. "Legume consumption is inversely associated with type 2 diabetes incidence in adults: A prospective assessment from the predimed study". *Clinical Nutrition* 37.3 (2018): 906-913.

5. Begum N., *et al*. "Nutritional composition, health benefits and bio-active compounds of chickpea (*Cicer arietinum* L.)". *Frontiers in Nutrition* (2023): 10.

6. Ettoumi YL and Chibane M. "Some physicochemical and functional properties of pea, chickpea and lentil whole flours". *International Food Research Journal* 22.3 (2014): 987-996.

7. Gautam AK., *et al*. "Characterization of chickpea (*Cicer arietinum* L.) lectin for biological activity". *Physiology and Molecular Biology of Plants* 24.3 (2018): 389-397.

8. Grigorenko. Woman shows chickpeas in close up. Chickpea are growing on the field. *iStock* (2017).

9. Guardado-Félix D., *et al*. "Effect of partial replacement of wheat flour with sprouted chickpea flours with or without selenium on physicochemical, sensory, antioxidant and protein quality of yeast-leavened breads". *LWT - Food Science and Technology* 129 (2020): 1-7.

10. Gupta N., *et al*. "Biochemical characterisation of lectin from wild chickpea (cicer reticulatum L.) with potential inhibitory action against human cancer cells". *Journal of Food Biochemistry* 43.2 (2018).

11. Gupta RK., *et al*. "Health risks and benefits of chickpea (*cicer arietinum*) consumption". *Journal of Agricultural and Food Chemistry* 65.1 (2016): 6-22.

12. Herranz B., *et al*. "Characterisation of chickpea flour-based gluten-free batters and muffins with added biopolymers: Rheological, physical and sensory properties". *International Journal of Food Science and Technology* 51.5 (2016): 1087-1098.

13. Hirdyani H. "Nutritional composition of Chickpea (*Cicerarietinum*-L) and value added products". *Indian Journal of Community Health* 26.2 (2014): 102-106.

14. Hussein H., *et al*. "Impact of chickpea as prebiotic, antioxidant and thickener agent of stirred bio-yoghurt". *Annals of Agricultural Sciences* 65.1 (2020): 49-58.

15. Karaca AC., *et al*. "Microcapsule production employing chickpea or lentil protein isolates and maltodextrin: Physicochemical properties and oxidative protection of Encapsulated Flaxseed Oil". *Food Chemistry* 139.1-4 (2013): 448-457.

16. Kaur R and Prasad K. "Nutritional characteristics and value-added products of Chickpea (Cicer arietinum) - a review". *Journal of Postharvest Technology* 9.2 (2021): 1-13.

17. Kumar K. "Fresh Raw whole chickpeas". iStock.

18. Kumar N and Sharma AK. "Study on engineering properties of chickpea (Cicer arietinum) seeds in relation to design of threshing mechanism". *The Pharma Innovation Journal* 10.9 (2021): 455-458.

19. Kumar R., *et al*. "Types of Chickpeas (I. Rosenthal, Ed.)". *Food and Agriculture Organization of the United Nations* (2017).

20. Laxmikanth., *et al*. "Study on physical properties of chickpea". *Journal of Pharmacognosy and Phytochemistry* 9.4 (2020): 511-514.

21. Longvah T., *et al*. "Indian Food Consumption Tables 2017, National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, Telangana, India (2017).

22. Madurapperumage A., *et al*. "Chickpea (*Cicer arietinum* L.) as a source of essential fatty acids - a biofortification approach". *Frontiers in Plant Science* 12 (2021): 1-12.

23. Mathew SE and Shakappa D. "A review of the nutritional and antinutritional constituents of chickpea". *Crop and Pasture Science* 73.4 (2022): 401-414.

24. Monk JM., *et al*. "Chickpea-supplemented diet alters the gut microbiome and enhances gut barrier integrity in C57BL/6 male mice". *Journal of Functional Foods* 38 (2017): 663-674.

25. Mudryj AN., *et al*. "Nutritional and health benefits of pulses". *Applied Physiology, Nutrition, and Metabolism* 39.11 (2014): 1197-1204.

26. Mustafa R., *et al*. "Aquafaba, wastewater from Chickpea Canning, functions as an egg replacer in sponge cake". *International Journal of Food Science and Technology* 53.10 (2018): 2247-2255.

27. O'Neil CE., *et al*. "Chickpeas and hummus are associated with better nutrient intake, diet quality, and levels of some cardiovascular risk factors: National Health and Nutrition Examination Survey 2003-2010". *Journal of Nutrition and Food Sciences* 04.01 (2014): 2003-2010.

28. Padalino L., *et al*. "Optimization and characterization of gluten-free spaghetti enriched with chickpea flour". *International Journal of Food Sciences and Nutrition* 66.2 (2014): 148-158.

29. Rachwa-Rosiak D., *et al*. "Chickpeas-composition, nutritional value, health benefits, application to bread and snacks: a review". *Critical Reviews in Food Science and Nutrition* 55.8 (2015): 1137-1145.

30. Rasool S., *et al*. "Chickpea". *Legumes under Environmental Stress* (2015): 67-79.

31. Rincon L., *et al*. "Development of novel plant-based milk based on chickpea and Coconut". *LWT - Food Science and Technology* 128 (2020): 1-9.

32. Sastry D., *et al*. "Determination of Physical Properties of Chickpea Seeds and their Relevance in Germplasm Collections". *Indian Journal of Plant Genetic Resources* 27.1 (2013): 1-9.

33. Singh S., *et al*. "Chickpea". In *Broadening the Genetic Base of Grain Legumes* (1st ed., pp. 51-73). essay, Springer, India (2014).

34. Sinha S., *et al*. "A study on some physical and engineering properties of the chickpea seeds". *International Journal of Current Microbiology and Applied Sciences* 8.11 (2019): 1504-1509.

35. Solanke ND., *et al*. "Study the Physical and Functional Properties of Chickpea and Black Gram Flours". *International Journal of Current Microbiology and Applied Sciences* 10.10 (2021): 277-282.

36. Vkbhat. "Close up of green garbanzo beans" *iStock*.

37. Wallace TC., *et al*. "The Nutritional Value and Health Benefits of Chickpeas and Hummus". *Nutrients* 8.12 (2016): 766.

38. Wang J., *et al*. "Nutritional constituent and health benefits of chickpea (Cicer arietinum L.): A Review". *Food Research International* 150 (2021): 110790.

39. Xue Z., *et al*. "Lipid metabolism potential and mechanism of CPE-III from Chickpea (cicer arietinum L.)". *Food Research International* 104 (2018): 126-133.