P4N: Peanut for Nutrition

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Preface

The human health, as defined by WHO, is "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity". During the last two decades, India has achieved tremendous growth in gross domestic products, food production, and per capita consumption. However, while it produces double the amount of foods to feed its present population of over 1.38 billion, India is unable to provide access of food to a large number of people due to inequities in the distribution of power, wealth and resources at local and national level. Even if the sufficient amount of food is served, many a times, the same is lacking in required amount of fat, protein, carbohydrates and mineral contents without which we cannot think of healthy people. The FAO, in their "State of Food Security and Nutrition in the World 2020 report", estimates 189 million (14%) India's population is under nourished; more than 50% of women in their reproductive stage are anemic, about 35% children under 5 year of age are stunted and 20% are underweight. The Global Hunger Index, 2019 rank India at 102 out of 117 countries. Thus, our food policies and systems should be more efficient, and resilient to accommodate present needs and also of the forthcoming generations. Zero Hunger is 2nd goal of the 17 sustainable development goals (SDGs) that many countries adopted in 2015 to address global challenges, poverty, hunger and malnutrition, climate change, inclusive growth and sustainable management of natural resources.

The government of India has launched many schemes, movements, from time to time to eradicate hunger and malnutrition and more recently flagship public health programmes such as *POSHAN Abhiyaan, Anemia Mukt Bharat, Ayushman Bharat Yojana and Swachh Bharat Mission* through mission mode. *POSHAN* (Prime Minister's Overarching Scheme for Holistic Nutrition) *Abhiyaan* or National Nutrition Mission, was launched in 2018, to improve nutritional outcomes for children, adolescents, pregnant women and lactating mothers by Leveraging technology" is an unique opportunity for eradication of under-nutrition making India malnutrition-free. Also, Government has launched a mass media campaign on "*Eat Right India movement"* through FSSAI with an aim of making available right, safe and sustainable food. Moreover, now the focus is being shifted to diet diversification. This will allow people to take charge of their own diet and health. Today's world is at the edge of nutritional transition where food should fulfill all criteria of being good in terms of nutrition, sustainability, and productivity (climate smart, high yields with multiple usages) for the farmers. Greater importance should be given to traditional, affordable and local food. In addition to cereals and pulses, consumption of nuts is vital as a source of oil, proteins and minerals for the people around the globe and the nuts should be eaten as a part of healthy diet to avoid obesity as also to prevent and manage chronic diseases. This technical bulletin is compilation of nutritive value of Peanut (a poor man's nut) and its dietary recommendations for balancing human nutrition.

A. L. Singh

Contents

1. Peanut Scenario

Peanut is the prime choice other than cereals for providing nutrition for urban and rural livelihood. It is now widely cultivated throughout the tropical and sub- tropical countries of Africa, Asia, North and South Americas where about 47 million tonnes of pods are produced from about 28 million hectares. The consumption has grown at a rate of 2.53% and is expected to grow further in the years to come. India is the second largest producer as well as consumer of peanut in the world with 68.57 lakh tonnes production (FAO, 2019). The crop area in India is at 40.12 lakh ha in 2018-19 down from 41.35 lakh ha in last year. Similarly, production and yield are estimated at 37.70 lakh tonnes and 931 Kg/ha respectively as against 52.75 lakh tonnes and 1269 Kg/ha respectively during previous year **(Fig. 1)**. India alone has exported peanut (in shell) of worth rupees three thousand crores in 2018-2019 **(Fig. 1)**. Around 50 per cent of peanut exports from India are destined to Indonesia, Vietnam, Philippines and Malaysia (**Fig. 2**). Peanut are consumed worldwide either as raw or as roasted, roasted-and-salted, fried, or boiled. It is also considered a ready-to-use therapeutic food (RUTF) to treat protein energy malnutrition in children. There are more than 50 million children in the world who suffer from malnutrition. Peanuts have been helping to fight childhood malnutrition across the world since 2005 in the form of RUTFs. The RUTF product is a peanut paste that also contains skimmed milk powder, vitamins and minerals. This combination in right proportion helps malnourished

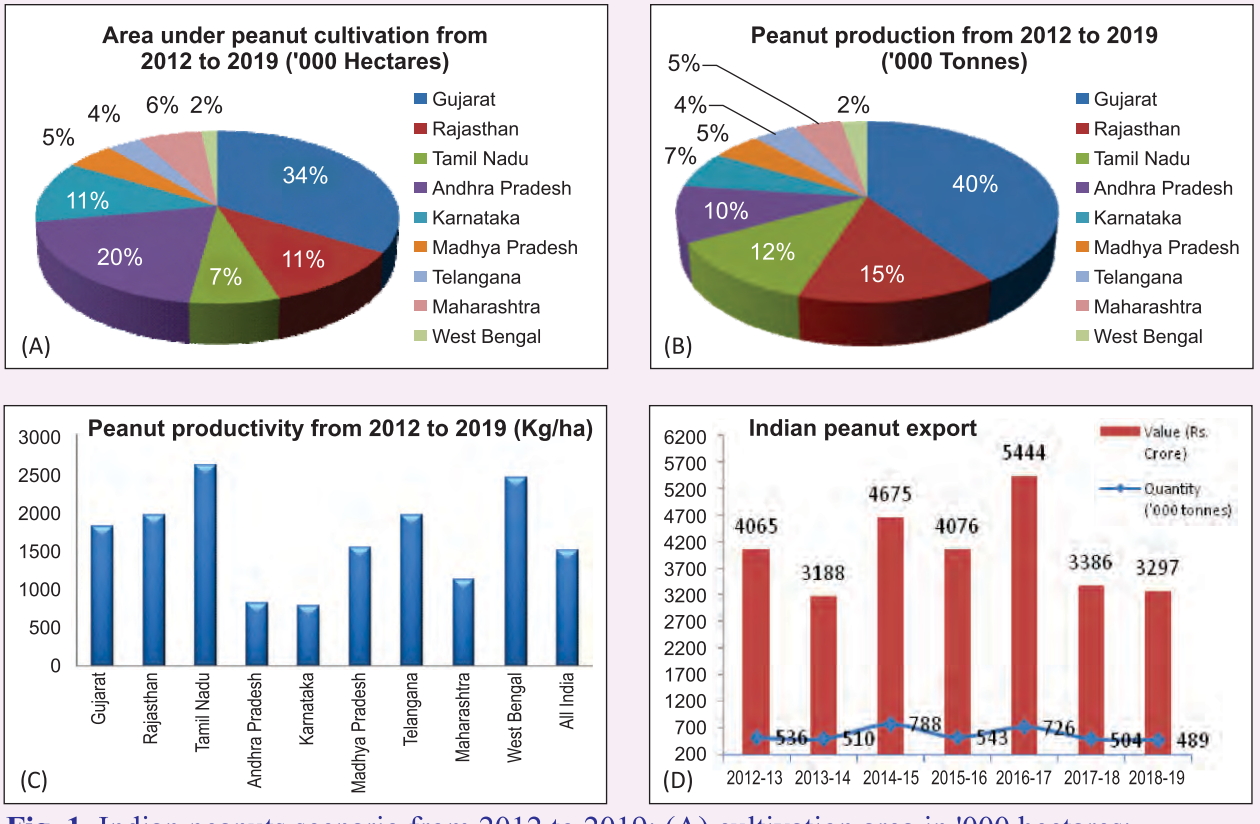


Fig. 1. Indian peanuts scenario from 2012 to 2019; (A) cultivation area in '000 hectares; (B) production in '000 tonnes; (C) productivity in Kg/ha; (D) export in Rs. Crores.

Source: Directorate of Economics and Statistics, Ministry Agriculture and Farmers Welfare, New Delhi, acessed on September 05,2020.

children recover in weeks. As malnutrition continues to affect millions of children, peanut-based RUTFs continue to be one of the most effective ways to treat it. However, except peanut all other nuts are costlier and not in the reach of everyone. This compilation is aimed at enhancing awareness about the nutritive virtues of peanut among people and at the same time helping them bringing together at one place to relish Indian preparations from peanut.

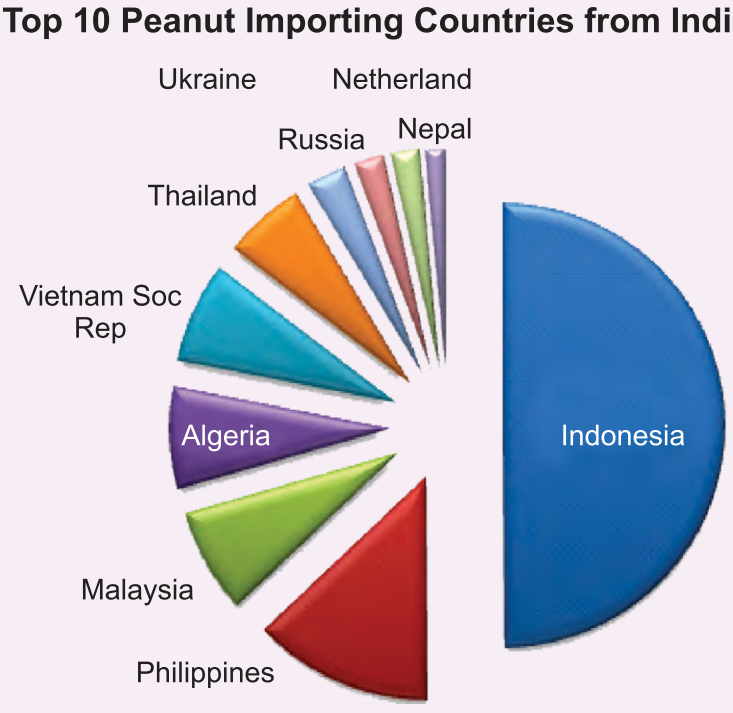


Fig. 2: Top ten peanut importing countries from India

2. Peanut: A Good Option for Small and Marginal Farmers

Peanut crop is a reasonably good choice for small and marginal farmers because:

- It is a climate resilient crop and can give reasonable yield even under stress conditions and on low fertility soil with low inputs.
- Being a leguminous crop, it enriches soil nitrogen and, if used in rotation with other crops, enhances water use efficiency of the cropping system. Peanut crop is now gaining attention in rice and potato fallows.
- Being a nutrient efficient crop, it can be cultivated in nutrient deficient soils and semi-arid environment and its crop residues can also be used as animal fodder.
- Only one third of its potential has been used, thus it has considerable scope for yield enhancement. By optimization of agronomic practices, the yield can be doubled.
- It has a broad genetic base from which even more climate resilient and nutrient dense varieties can be developed.
- Serve as a key ingredient in many traditional home-made dishes like *poha, tahri, dal, rasam* and used in the preparation of *chikki, namkeens*, chocolates, candies etc.



3. Nutritional Value of Peanut Kernels

Peanut is highly nutritious and has a good potential to address protein and micronutrient deficiencies and meet the daily needs. The benefits of its nutritional quality are as follows (**Table 1**):

- Peanut is an easily affordable source of important nutrients compared with other popular nuts like almond walnut, pistachio and cashew.
- Heart healthy oil - Oleic acid (18:1) and linoleic acid (18:2) constitute ≈ 80% of the total fatty acids
- From flavor and quality point of view, its oil is among the top three vegetable oils (peanut, safflower and rapeseed) that are widely consumed in India.
- It contains lipids (40-54%) and proteins (20-30%), the contents of which vary with cultivars and environment.
- As peanut matures, the moisture and carbohydrate content decreases with subsequent increase in oil content, whereas protein content remain unchanged.
- The proximate composition of peanut and its comparison with other major foodstuffs and nuts are given in **Table 2** & **3**.
- High in iron, zinc, calcium and magnesium – Peanut has high mineral content and bioavailability studies show that it can provide an average person's daily requirement.

Table 1 Nutritional and Bioactive Compounds in Indian Peanut cultivars (values per 100 g)

Components	Values	RDA (%)
Energy	567 Kcal	29
Carbohydrates	16.13 g	12
Protein	25.80 g	46
Fats	49.24 g	165
Fiber	8.5 g	22
Water	6.5 g	-
Vitamins (µg)		
Folate	240	60
Niacin	12066	75
Pantothenic acid	1767	35
Pyridoxine	348	27
Riboflavin	135	10
Thiamin	640	53
Vitamin E	833	55.5
Minerals		
Calcium	92 mg	9
Sodium	18 mg	1
Potassium	705 mg	15
Copper	1.14 mg	127
Iron	4.58 mg	57
Magnesium	168 mg	42
Manganese	1.93 mg	84
Phosphorus	76 mg	54
Selenium	7.2 µg	13
Zinc	3.27 mg	30

Source: NIN, 2017

- It's protein has a balanced amino acid profile with high digestibility
- Appreciable levels of carbohydrates (16-22%) with resistant starch
- It is a good source of fat soluble vitamins (A, D, E and K). On the other hand, peanuts have appreciable amount of niacin (12.066 mg per 100 g) from

Table 2: Proximate Principles and Dietary Fibre of Various Foodstuffs (g/100g)

Foodstuffs	Moisture	Protein	Ash	Fats	Total fibres	Carbohydrates	Energy (KJ)
Nuts and Oilseeds							
Almonds	4.4	18.4	2.6	58.5	13.1	3.0	2549
Cashew	4.4	18.8	2.3	45.2	3.9	25.5	2438
Coconut, kernel	4.0	7.3	1.6	63.3	15.9	8.0	2611
Peanuts	7.0	23.7	2.1	39.6	10.4	17.3	2176
Mustard	5.7	19.5	8.7	40.2	14.1	16.2	2132
Linseeds	5.5	18.6	3.2	35.7	26.2	11.0	1857
Pistachio	4.7	23.4	3.0	42.5	10.6	15.8	2257
Safflower	5.2	17.7	2.6	30.9	13.5	30.2	1981
Sunflower	3.5	23.5	3.4	51.9	10.8	6.9	2453
Cereals and Millets							
Maize, dry	9.3	8.8	1.2	3.8	12.2	64.8	1398
Rice, raw	9.9	7.9	0.6	0.5	2.8	78.2	1491
Wheat, whole	10.6	10.6	1.4	1.5	11.2	64.7	1347
Grain Legumes							
Bengal gram	8.6	18.8	2.8	5.1	25.2	39.6	1201
Cow pea	9.4	20.4	2.9	1.2	11.5	54.6	1340
Green gram	9.8	23.9	3.0	1.4	9.4	52.6	1363
Soybean	5.5	35.6	4.7	19.8	21.6	12.8	1596
Milk and Dairy Products							
Cow Milk	86.6	3.3	0.7	4.5		4.9	305
Egg, poultry	76.5	13.3	0.8	9.2			564
Chicken, thigh	67.6	18.2	1.1	14.2			836
Animal Meat							
Goat shoulder	66.4	20.3	0.9	11.9			787
Fresh water Fish							
Rohu	76.3	19.7	1.3	2.4			428

Source: NIN, 2017

vitamin B complex which reduces the risk of respiratory distress syndrome and neural tube defects in infants.

- Low Glycemic index (GI) due to its fibre and carbohydrate composition. GI of peanut is 14 on a 100 point scale where as glycemic load (GL) is one only.
- It is rich in phenols and flavonoids which are antioxidants (Mahatma et al 2016) and anti-cancerous also.
- Digestibility – Peanut components are highly digestible with 0.70 score of PDCAAS out of 1 where as it is 0.46 for whole wheat and 0.77 for soy flour (50% protein).
- Low food wastage footprints – Peanut can be stored for extended periods without losing their nutritional value and quality.

Table 3: Comparison of Nutritional Composition of Peanut with other Major Nuts

Composition	Peanut	Almond	Cashew nut	Pistachio	Walnut
Moisture (%)	6.50	4.70	5.20	4.81	4.07
Energy (kcal)	567	575	553	562	654
Protein (%)	25.80	21.22	18.22	20.27	15.23
Lipid (%)	49.24	49.42	43.85	45.39	65.21
Carbohydrates (%)	16.13	21.67	30.19	27.51	13.71
Fiber (%)	8.5	12.2	3.3	10.3	6.7
Minerals (%)	1.6	2.48	2.66	3.21	1.82
Calcium (mg)	92	264	37	105	98
Iron (mg)	4.58	3.72	6.68	3.92	2.91
Magnesium (mg)	168	268	292	121	158
Phosphorus (mg)	376	484	593	490	346
Potassium (mg)	705	705	660	1025	441
Thiamine (mg)	0.64	0.21	0.42	0.87	0.34
Riboflavin (mg)	0.14	1.01	0.06	0.16	0.15
Niacin (mg)	12.07	3.38	1.06	1.30	1.13
alpha-Tocopherol (mg)	8.33	26.22	0.90	2.30	0.70
Total saturated fatty acids (g)	6.83	3.73	7.78	5.56	6.13
Total mono unsaturated fatty acids (g)	24.43	30.89	23.8	23.82	8.93
Total poly unsaturated fatty acids (g)	15.56	12.07	7.85	13.74	47.17

Source: NIN, 2017

3.1 Peanut Oil Composition

- ✓ Oil content ranges from 40 to 54 %
- ✓ Possess well-balanced fatty acid profile and antioxidant content
- ✓ It is free from Trans-fat and cholesterol; low in saturated fats
- ✓ It's major fatty acids are oleic acid (C18:1) – a MUFA and-, linoleic acid (C18:2) - a PUFA and palmitic acid- a saturated fatty acid (**Table 4, 5**).
- ✓ Sum of oleic and linoleic acids (%) of total fatty acids and O/L ratio increases with maturity.

3.2 High Oleic Peanut Varieties

- ✓ ICAR-DGR in collaboration with ICRISAT has developed two high oleic acid (nearly 80%) groundnut varieties Girnar 4 and Girnar 5 for cultivation in India.
- ✓ Peanut products with high oleic acid content will have extended shelf life.
- ✓ High Oleic oil is considered a health-oil as it can reduce the risk of cardiovascular diseases, promotes a healthier ratio of high density lipoprotein (HDL) to low density lipoprotein (LDL), and reduces triacylglycerol and blood glucose levels.

Table 4: Fatty Acid Composition (%) of Major Vegetable Oils

Source of oil	Myristic acid (C14:0)	Palmitic acid (C16:0)	Stearic acid (C18:0)	Oleic acid 18:1	Linoleic acid (C18:2)	Linolenic acid (C18:3)	Erucic acid (C22:1)
Groundnut	-	10.5	3.4	53.8	27	0.3	-
Mustard	2.2	1.2	1.0	10.2	15.6	11.7	51.2
Coconut	21.1	9.3	3.0	7.2	1.9	-	-
Sunflower	-	6.4	3.7	25.9	62.7	-	-
Safflower	0.2	6.2	2.3	13.8	76.6	0.13	-
Sesame	-	8-12	3-8	35-47	28-47	-	-
Soybean	-	11.7	3.9	24.8	54.2	5.2	-
Palm	1.0	39.0	4.2	43.4	11.2	0.3	-
Cotton seed	0.9	23.4	2.8	17.8	51.8	0.35	-
Corn (Maize)	-	12.9	2.1	32.0	49.0	0.8	-
Rice bran	0.35	19.3	2.0	43.4	32.0	0.6	-

Table 5: Characteristics of Major Vegetable Oils

Source of Oil	TSFA	MUFA	PUFA	PUFA / SFA	Omega6 / Omega3
Groundnut	19.3	53.8	27	1.4	90
Mustard	5.7	67	27.3	4.8	1.3
Coconut	90.8	7.2	1.9	0.02	-
Sunflower	-	-	-	5.5	-
Safflower	9.2	14	76.8	8.4	631.6
Sesame	25.4	36.6	39.2	2.3	88.5
Soybean	15.9	24.8	59.3	3.7	10.5
Palm	44.8	43.6	11.5	0.26	37.4
Cotton seed	28.17	19.7	52.2	1.8	146.7
Corn (Maize)	16.6	33.7	49.7	3.0	64.15
Rice bran	23.6	43.7	32.7	1.4	54.3
Olive	14.2	67.0	7.9	0.6	-

Total saturated fatty acid (TSFA); Monounsaturated fatty acid (MUFA); Polyunsaturated fatty acid (PUFA); Saturated fatty acid (SFA); Sources: Khetarpaul et al 2014; Dorni et al 2018; Johnson and Saikia, 2009

3.3 Peanut Protein Quality

Protein is the second major constituent of peanuts governed by both genetic and environmental factors. The crude protein (%) of seed decreases during fruit growth after 3 weeks but not below 20-30% of dry weight. In many areas, where meat, dairy and fish are expensive sources of protein and are economically inaccessible for many, peanut is a good choice for dietary protein **(Fig. 3)**. Protein values were estimated by using conversion factors (Jones 1941) from the estimated total nitrogen in the foodstuffs **(Table 7)**.

- ✓ Peanut have 20 to 30 % protein, although few germplasm lines showed as high as 33.25% protein (Misra et al 2000).
- ✓ Cultivars JL-24, TG-5, Kadiri-3, GAUG10, S-230, Kadiri-1 and J-11 have more than 30% protein content.
- ✓ The protein content of the de-oiled cake is up to 50-55%; which is used as animal feed supplement
- ✓ Peanut protein is rich in arginine but lysine, methionine and cysteine are the limiting amino acids.
- ✓ Protein digestibility corrected amino acid score (PDCAAS) of peanut protein is nutritionally equivalent to those of meat and eggs **(Table 6)**.

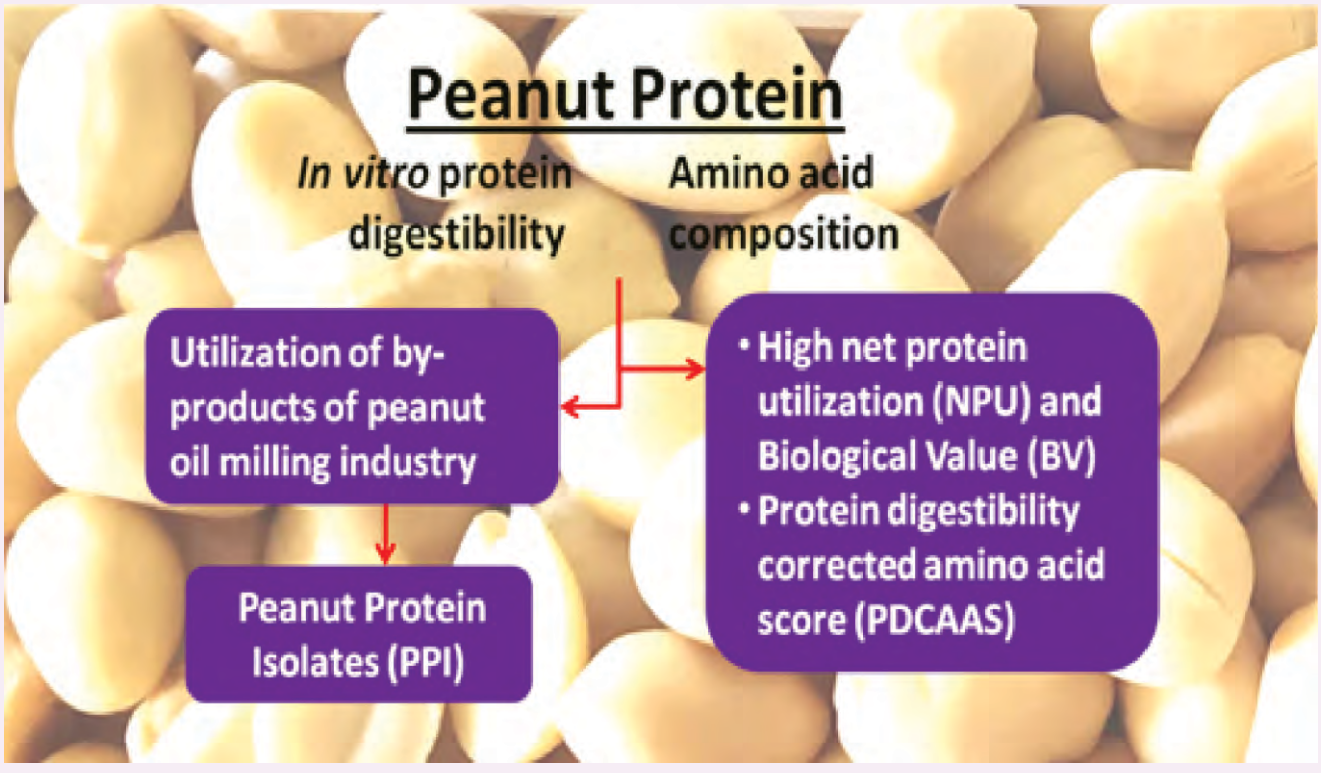


Fig. 3: Assessment and utilization of quality of peanut protein

Table 6: Comparison of protein value and digestibility of peanut protein with other protein sources

Protein source	Rat bioassay			Relative value in human	Mean digestibility in adults
	RPV	NPR	PER		
Peanut flour	52	61	1.59	79	94
Soy protein isolates	47	70	1.77	77	95
Wheat gluten	25	32	0.45	75	-
Egg white	100	100	2.85	100	-
Animal protein	-	-	-	-	96

Relative protein value (RPV), net protein ratio (NPR), protein efficiency ratio (PER); Source: Singh and Singh 1991

Table 7: Jones factors for conversion of nitrogen to protein

Foodstuff	Conversion Factor
Peanuts	5.46
Almonds	5.18
Wheat whole	5.83
Soybean	5.71
Cashew, pistachio, chest nut	5.30
Meat and fish	6.25
Milk and its products	6.38
Sunflower seeds	5.30

Source: NIN, 2017

3.4 Peanut Processing Methods

In terms of health benefits, minimally processed foods are considered better than the highly processed foods. Peanuts are generally processed using a variety of methods, such as water soaking, sprouting, boiling, roasting, frying and steaming.

- ✓ Boiling and roasting significantly reduces the levels of oxalate, tannins, phytate, trypsin inhibitor.
- ✓ Virginia bunch type peanuts develop roasted aroma to a greater extent than Spanish bunch type during roasting.
- ✓ Peanuts roasted at lower temperature had higher tocopherol content.
- ✓ Soaking and boiling enhance the digestibility of peanut due to activation of enzymes.

3.5 Peanut: A Source of Carbohydrates

- ✓ Carbohydrates in peanut are present in free and bound form in a range of 16-22%
- ✓ Constitute mono- and oligosaccharides, starch, hemicelluloses A and B, cellulose or fibre
- ✓ Sucrose (2.6-6.5 %), stachyose (0.1-0.7%), myo-inositol (0.03-0.17%) and raffinose (0.01-0.12%) are major sugars (Fig. 4, 5; Bishi et al 2015; Mahatma et al 2020).
- ✓ Free sucrose mainly contribute to peanut's sweetness.
- ✓ Myo-inositol possesses therapeutic potential in the treatment of diabetic neuropathy.
- ✓ Raffinose family oligosaccharides (RFOs) are more in Virginia habit group than Spanish.

- ✓ The crude fiber content of peanut ranges from 2 to 4 %.
- ✓ Resistant Starch (RS) fraction varied from 0.1 to 0.2 g per 100 g based on inherent genotypic differences.
- ✓ Energy value of RS is 8 kJ/g (2 kcal/g) and about 20 g per day of RS is recommended to have its health benefits.
- ✓ RS improves colonic health, absorption of intestinal iron and calcium and prevents colonic cancer, gall stone formation and insulinemia.
- ✓ RS not only lowers the calorific value but also improves texture, appearance, and organoleptic qualities of the peanut foods.

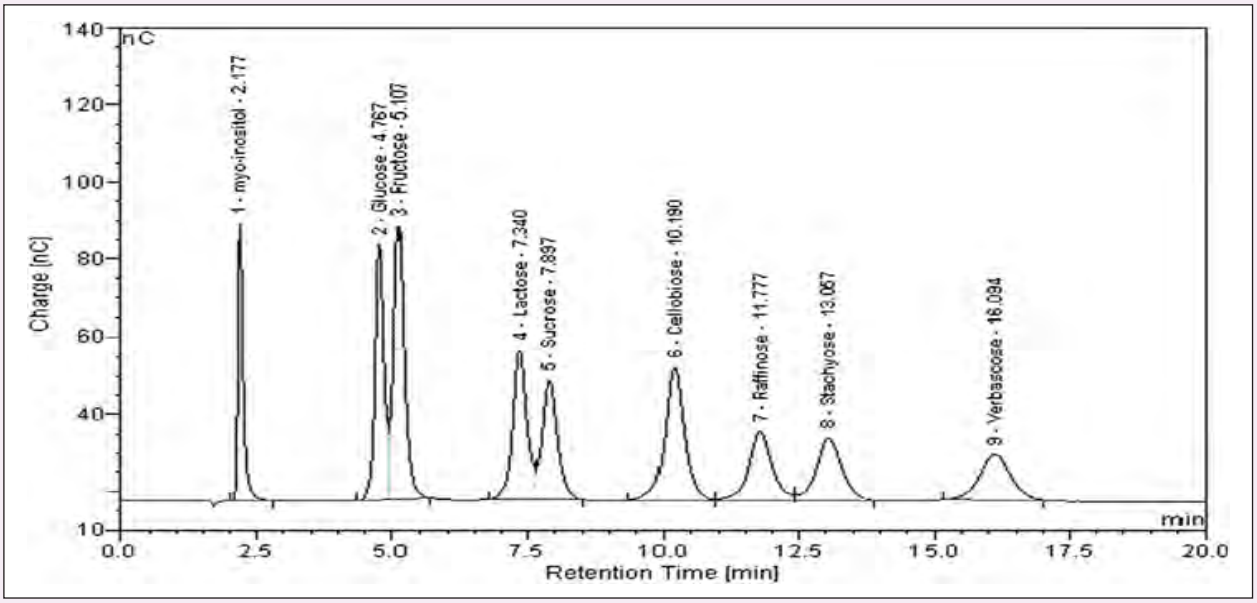


Fig. 4: Chromatogram of standard saccharides in ion chromatograph. Mixture of sugar standards were separated in an ion chromatograph (Dionex, ICS 3000) equipped with CarboPac PA10 analytical column using 150 mM NaOH, pH 12.8 as eluent with flow rate 1 ml min^{-1} (Bishi et al 2015)

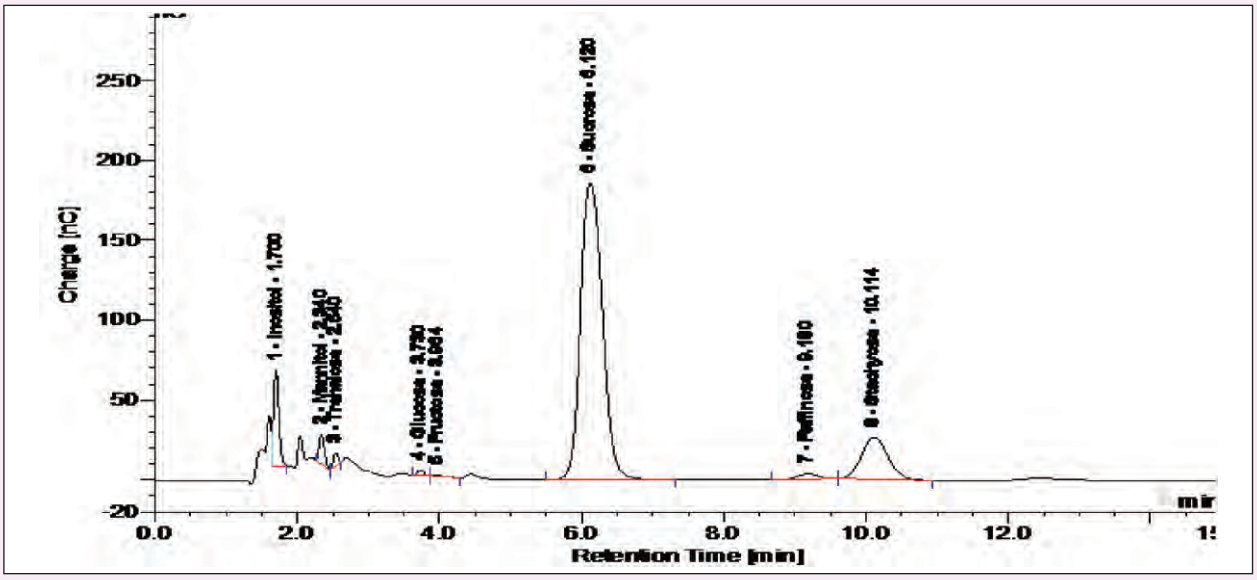


Fig. 5: Separation of saccharides from GG-20 genotype kernels by using ion chromatograph.

3.6 Peanut: Phytochemicals and Antioxidants

- ✓ Peanuts contain a wide range of antioxidative phytochemicals of which phenolics, flavonoids and stilbenes **(Fig. 6)** are of main importance (Mahatma et al 2018).
- ✓ They are secondary plant metabolites which are anti-inflammatory, antimicrobial and anti-cancer.
- ✓ Cinnamic acid, catechol and kaempferol are predominant phenolics in peanut while salicylic acid, syringic acid and epicatechin are also detected in traces (Fig. 7, 8; Mahatma et al 2018).
- ✓ Total phenolic content is more predominant in testa and testa-removed kernels and varied from 2.47 to 84.53 and 0.07 to 0.12 mg gallic acid equivalent (GAE)/g dry weight, respectively (Bishi et al 2015).
- ✓ Resveratrol, a major component of red wine, grapes, is also present in peanut testa and is in several folds than grapes.

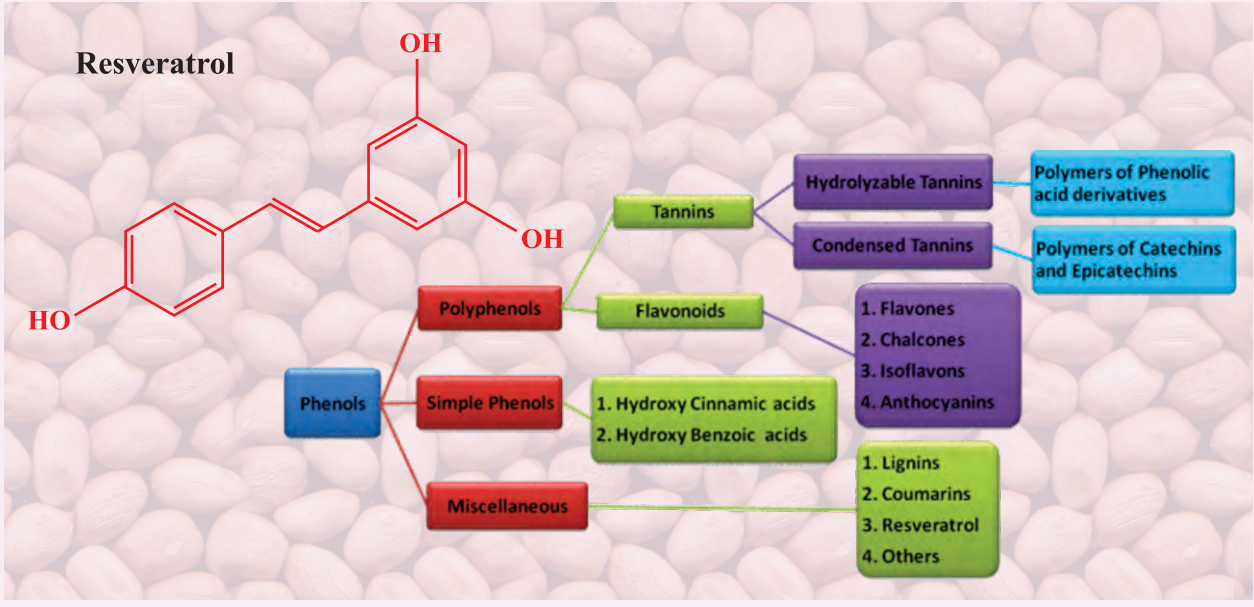


Fig. 6: A glimpse of types of phenols, majority of which are present in peanut testa and testa-removed kernels

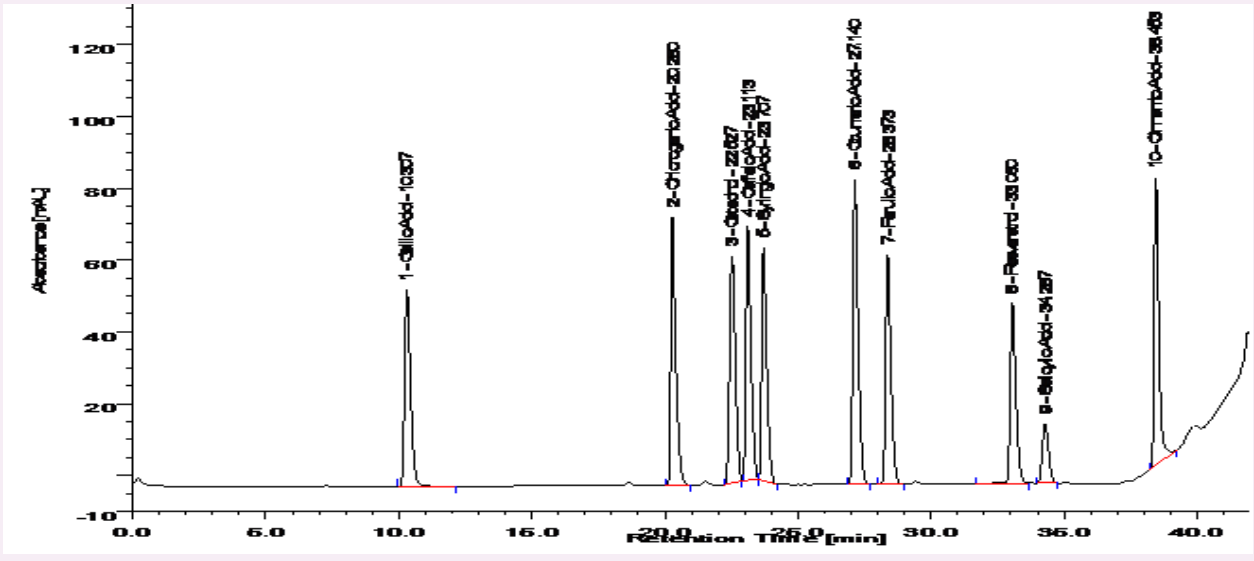


Fig. 7: Chromatogram of standard phenols in ion chromatograph

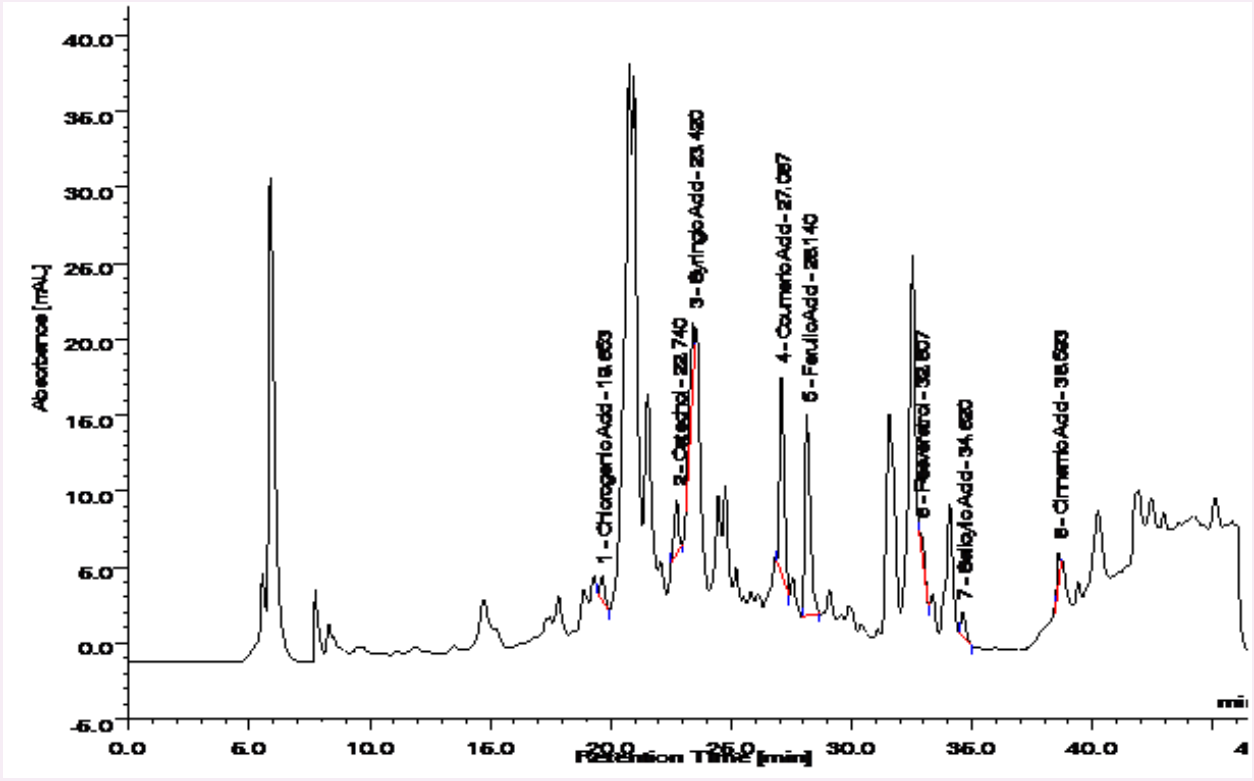


Fig. 8: Ion chromatogram of phenols extracted from TG 37A kernels

3.7 Bioactive Components of Peanuts

Peanut is considered as a superfood due to the presence of many bioactive components **(Fig. 9)**.

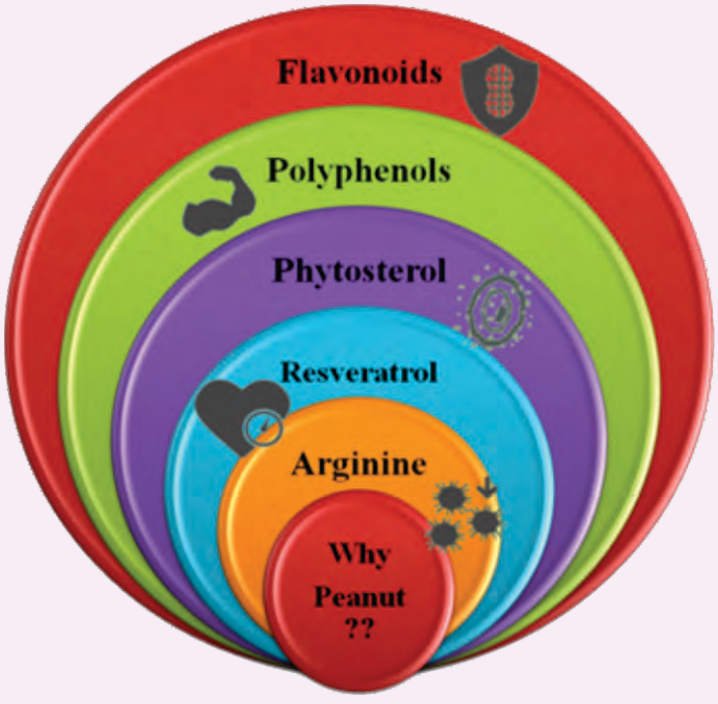


Fig. 9: Diagram representing Bioactive compounds in Peanuts

3.7.1 Sterols

- ✓ Oil, butter, and flour of peanut are good sources of phytosterols.
- ✓ gamma-sitosterol (78–83%), campesterol (6–14%) and stigmasterol (3–11%) are the major sterols.
- ✓ Refining of peanut oil results in reduction in phytosterols concentration.
- ✓ Phytosterols lower cholesterol by blocking absorption of dietary cholesterol and reducing reabsorption of cholesterol from the liver.

3.7.2 Minerals

- ✓ Minerals are inorganic micronutrients and are crucial for metabolic activities, formation of bones, nerve conduction, etc.
- ✓ Peanuts contain good amount of macronutrients and is a rich source of iron and zinc.
- ✓ Consumption of 100 g of peanut can provide RDA levels of 127% of copper, 84% of manganese, 57% of iron, 54% of phosphorus, 42% of magnesium and 30 % of zinc.

3.7.2.1 Iron and Zinc Densities and their Bio-fortification in Peanut

In a series of experiments conducted at DGR, Junagadh the high zinc (Zn) and iron (Fe) containing peanut cultivars and their biofortification methods were identified.

Study of 103 peanut cultivars of india showed a large variation, 39-67 mg kg^{-1} with a mean value of 54.7 mg kg^{-1}, in the seed Zn density among these and accordingly the groundnut cultivars were finally categorised **(Table 8)**. Of the 103 cultivars, 16 were low in Zn density showing less

Table 8: Categorization of 103 peanut cultivars for seed Zn density based on two years pooled data (Singh et al 2011)

Categorization and Zn content in seed (mg kg^{-1})	Peanut Cultivars
High (more than 63 mg kg^{-1})	TKG 19 A, BG 3, Somnath, ICGV 86590, M 145, M 197, M 13, CO 1,B- 95, Tirupati 3, Gangapuri, CO 2, KRG 1, CSMG 884, GG 7, TAG 24
Medium (51 -63 mg kg^{-1})	DRG 101, Tirupati 4, GG 12, Tirupati 1, 38, SG 84, Chitra, Kadiri 3, CSMG 84-1, AK 12-24, JSP 19, TG 17, DRG 17, M 522, UF 70-103, MH 2, GG 20, MH 4, LGN 2, ICGS 37, SB XI, MH 1, GG 5, ICGV 88448, BAU 19, ALR 2, ICG (FDRS) 4, TG 26, ICG (FDRS) 10, VRI 3, DH 8, TMV 2, Jawan, HNG 10, ICGS 5, ICGV 86031, TNAU 256, ICGS 1, NRCG 3498, SP 250 A, RG 141, GG 2, ALR 3, ICGS 11, DRG 12, Spanish Improved, Tirupati 2, Kadiri 2, Jyoti, JL 220, ALR 1, JL 24, M 335, ICGV 86325, GG 6, KISAN, ICGS 76, S 230, , S 206, TG 22
Low (less than 50 mg kg^{-1})	Chico, RS 1, Karad 4-11, VRI 2, GG 3, GG 4, T 64, ICGS 44, GG 13, Punjab 1, TG 32 , R 9251, TG 3, R 8808, DSG 1, GG 11, GAUG 10, Kadiri 4, K 134, MH 4, BAU13, Girnar 1

than 51 mg kg^{-1} Zn, 70 cultivars were medium in Zn density showing 51-63 mg kg^{-1} Zn in their seeds. However, 17 cultivars, which showed more than 63 mg kg^{-1} Zn in their seeds, were categorized as high Zn density groundnut cultivars.

In a similar fashion the peanut cultivars were screened and 13 high Fe cultivars (MH 4, Somnath, ICGV 86031, ICGV 86325, Tirupati 3, GG 2, M 145, M 13, DSG 1, AK12-24, TAG 24, ALR 3, JSP 19) with more than 125 ppm Fe in their seeds were identified (Singh and Chunilal 2007). Foliar application of these Fe and Zn as sulphate salts enriched Fe and Zn in seed.

These high Zn and Fe density cultivars need extensive cultivation and consumptions as food to combat the Zn and Fe malnutrition in India.

3.7.3 Arginine

- ✓ Peanuts contain arginine, an amino acid, which strengthens the immune system and regulates blood sugar. Arginine improves liver, skin, joint and muscle health and has been linked to improving blood circulation and keeping arteries flexible.

3.7.4 Vitamins in Peanuts

- ✓ Peanut oil contains vitamin E (tocopherol) as a major antioxidant
- ✓ Peanut contains alpha-tocopherol (48 to 373 µg/mL), beta-tocopherol (0 to 140 µg/mL), gamma-tocopherol (88 to 389 µg/mL), and delta-tocopherol (0 to 20 µg/mL).
- ✓ Peanut also contains vitamins A, B complex, and K in significant amount.
- ✓ Fat and water soluble vitamins in nuts and oilseeds are compared in table 9 and 10.

Table 9: Water Soluble Vitamins in nuts and oilseeds (µg/100g)

Nuts and Oilseeds	Thiamine (B_1)	Riboflavin (B_2)	Niacin (B_3)	Pantothenic Acid (B_5)	Total B_6	Biotin (B_7)	Total Folate (B_9)
Peanuts	600	100	11400	1000	200	2	91
Cashew nut	600	30	1000	1400	200	3	25
Coconut	40	40	700	200	200	1	24
Almonds	200	300	3700	700	100	2	37
Mustard seeds	600	300	3800	500	200	2	95
Linseeds	300	50	1100	400	400	21	87
Pistachio nuts	1000	40	900	600	1000	12	65
Safflower	900	200	1100	900	1000	17	82
Sunflower	600	100	1600	1000	900	2	82

Table 10: Fat Soluble Vitamins in nuts and oilseeds (µg per 100g)

Food Name	Ergocalciferol (D_2)	α-Tocopherol	Phylloquinones (K_1)
Peanuts	7.1	300	2.5
Cashew nut	3.9	1100	1.8
Coconut, kernel	-	6100	2.9
Almonds	1.6	25900	8.4
Mustard seeds	31.8	500	8.2
Linseeds	0.6	8300	19.2
Pistachio nuts	1.8	33900	18.7
Safflower seeds	1.9	35100	8.8
Sunflower seeds	1.5	12900	9.2

4. Anti-Nutritional Factors in Peanut

Although peanuts are known for its nutritional virtues but the kernels also have a few anti-nutritional factors.

4.1 Allergens

- ✓ Peanut allergy, more predominant in European and American countries, is associated with severe anaphylactic reactions.
- ✓ There are 16 proteins in peanuts which are recognized as allergens
- ✓ Allergen Ara h1, Ara h2, and Ara h3 are the main elicitors for the production of specific Ig E antibodies.

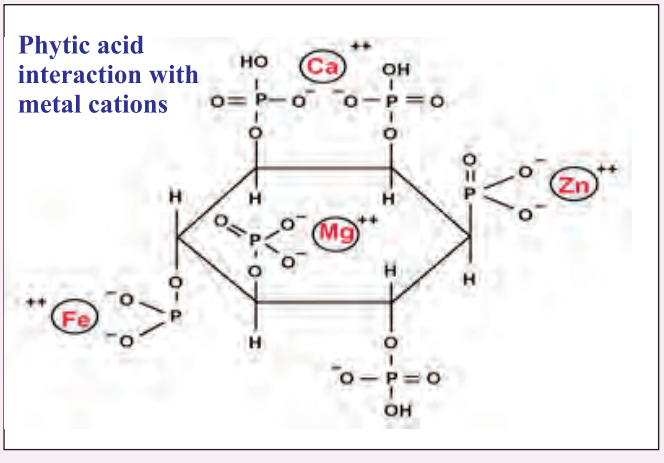
4.2 Phytic Acid

- ✓ Peanut kernels contain 0.17- 4.47% phytic acid
- ✓ It reduces bioavailability of mineral ions mainly Zn, Fe, and Ca due to its high binding affinity (Fig. 10)
- ✓ It interferes with protein digestibility by competing for mineral cofactors needed by peptidases
- ✓ Soaking in water for 4-8 h reduces phytic acid by activating phytases. This ensures easy digestion and absorption of nutrients especially of minerals.

4.3 Flatus Sugars

- ✓ Raffinose family oligosaccharides (RFOs) *viz.* raffinose, stachyose and verbascose are the major flatus sugars present in peanuts (Bishi et al 2013).
- ✓ These RFOs are fermented by anaerobic bacteria in the lower intestine and causes flatulence.

Certain other anti-nutritional factors present in peanut are trypsin inhibitor, oxalate, lectins and saponins. Post-harvest deterioration in quality of peanuts is also due to aflatoxin contamination which generally arises due to improper storage conditions.



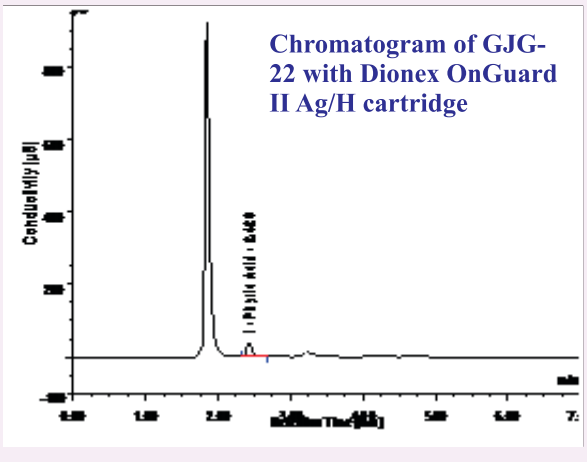


Fig. 10: Structure of phytic acid and its estimation from GJG-22 from Ion chromatography

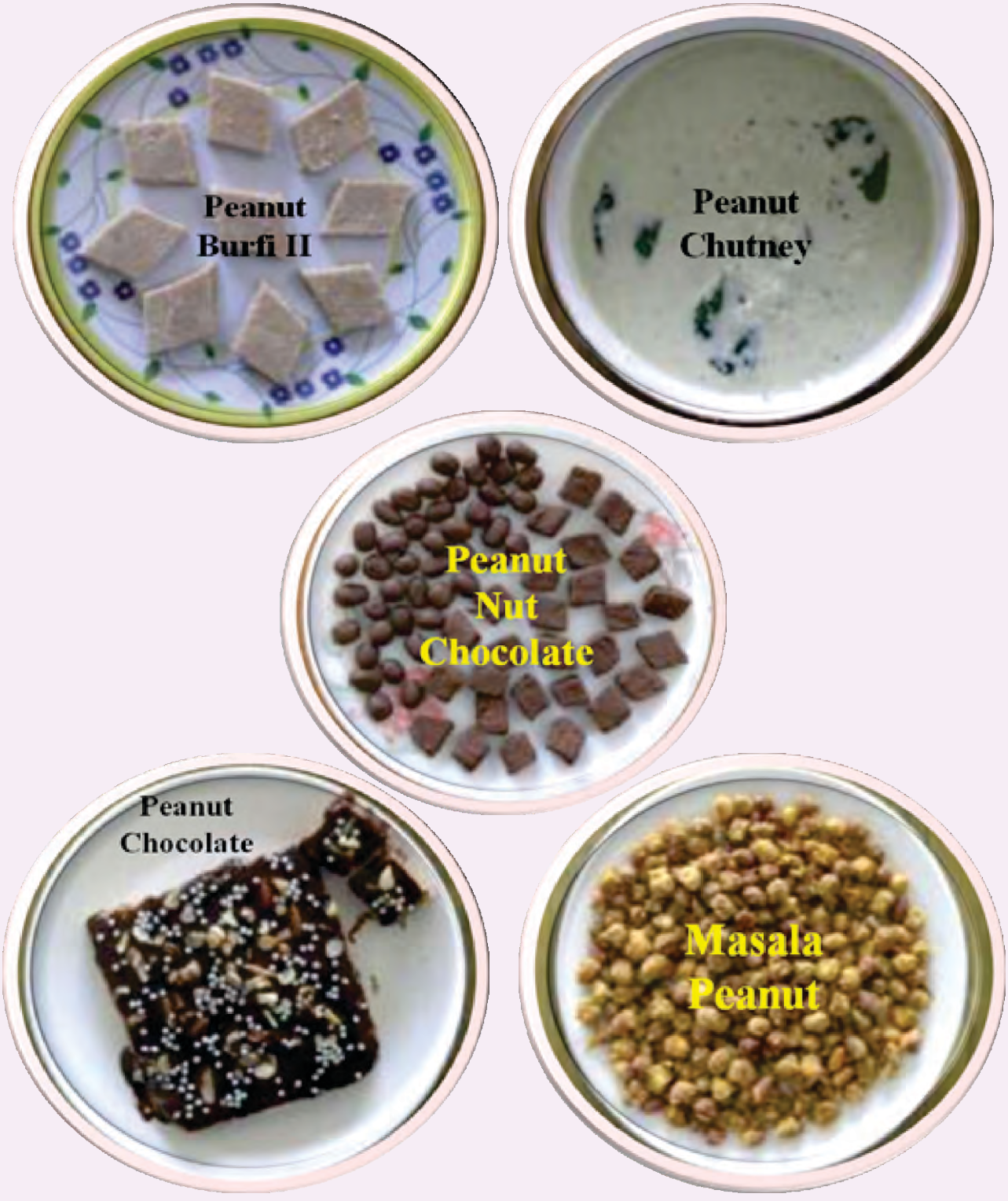
5. Peanut Value Added Products

Peanut is unique among oilseeds as it can be consumed directly as well as after blending with a variety of foodstuffs. The traditional Indian cookery uses

Table 11: Nutritive value of peanut products and preparations

Preparations	Content per 100 g					
	Energy (Kcal)	Carbohydrates (g)	Protein (g)	Fats (g)	Minerals (g)	Fibre (g)
Peanut butter	572	29	24	40	4	3
Peanut burfi-1	298	13	12	22	1	2
Peanut burfi-2	341	15	14	25	1	2
Peanut chutney	218	8	6	18	1	1
Peanut chocolate	464	59	12	20	1	1
Masala Peanut	527	29	24	35	2	3
Peanut shakarpare	484	63	13	20	1	2
Peanut milk	99	5	4	7	0	1
Peanut curd	99	5	4	7	0	1
Peanut halwa	632	32	9	52	2	0.5
Peanut vada	417	43	14	21	1	2
Salted Peanut	567	26.1	25.3	40.1	2.8	3.1
Peanut chikki	436	19	18	32	2	2
Peanut flakes	567	26.1	25.3	40.1	2.8	3.1
Peanut gujjhia	478	61	9	22	1	1
Peanut kachori	563	39	14	39	1	1
Wheat-Peanut *chapati* (9:1)	368	66.7	13.2	5.4	1.6	1.4

groundnut to prepare a variety of delicious and nutritious dishes (**Table 11**). Peanut is among those few gifts of nature that are inherently rich in important nutrients and one of the cheap sources of quality protein (Misra et al 2006).




Peanut
Halwa


Peanut
Burfi I


Peanut
Shakarpare


Peanut
Chikki


Peanut
Vada


Peanut Milk


Peanut
Butter


Peanut
Kachori


Peanut
Flakes


Peanut Curd


Peanut
Gujjhia


Salted
Peanut

6. Pick your Peanut: Trait Specific Varieties

Peanut is gaining importance in India due to it's nutritional value and multiple usage. It is readily available at an affordable price as compared to other rich sources of oil and protein. Many of the entrepreneurs have come out with retailing various peanut based products. Keeping in mind the specific demands of the farmer community and stakeholders, a brief of trait specific list of released varieties are presented in the **table 12**, so as to make the choice based selection convenient for users.

Table 12: Quality specific peanut varieties for various purposes

Quality	Range of population	Varieties
High Oil	43.5-55.5 %	Kadiri-9, Girnar-2, GJG-22, JL-776, GG20*, AK159*
Low Oil	43.5-55.5 %	ICGV91114, Dharani, ICGV00440, Kadiri7, TG51
High Oleic acid	38.01-62.02 %	TPG41, GJG18, GJG22, GG20, BAU-13, Girnar 4,5
Low Palmitic acid	7.62-12.72 %	GJG18, BAU-13, GG20, TKG19A, GJG22*, TLG45*
High Protein	20.9-36.1 %	TG51, Kadiri7, Dharani, ICGV-00440, TG37A
High soluble Sugars	36469-83842 (ppm)	TG-51, TPG-4, Girnar-3, TLG-45, TG-26
High Sucrose	30521-69393 (ppm)	Girnar-3, GG-20, TG37A, TG-51, ICGV00440
Low RFOs	2062-8815 (ppm)	TG-51, GJG-18, Kadiri-9, GJG-22, GPBD-4
Low soluble Sugar	36469-83842 (ppm)	GPBD-4, VRI-2, KADIRI-9, JL-776, Girnar-2
High Zinc	24-47 (ppm)	JL-776, JL-501, TG-26, GG-7, Dharani
High Iron	36-89 (ppm)	TG-51, Kadiri7, GG-5, GJG-22, GG20*, GPBD4*
High Potassium	4240-6022 (ppm)	AK159, TKG19A, Dharani, Kadiri7, Girnar3
High Minerals	1.13-2.91 (mg/g)	Girnar-3, JL-776, GG-14, GAUG-10*, Kadiri Harithandra*
High Phenols	1.49-3.61(mg/g)	Kadiri7, Girnar3, ICGV00440, Dharani, GJG22*, TKG19A*, Kadiri Harithandra*
High Antioxidants	7.21-17.41 (mM trolox eq.)	JL501, GG20, GG5, TG-39, BAU13, Kadiri Amaravathi*, GG7*, TG37A*, VRI2*
High Resveratrol	0.47-7.13 (µg/g)	GG-20, GG-7, TAG-24, GG5, TG39
High Catechin	08.5-16.66 (µg/g)	Dharani, GG-7, TG 37A, GPBD4, GJG-18
High p-Coumaric acid	3.25-4.67 (µg/g)	TAG-24, ICGV-91114, TG 37A, TG-39, GG-7
High Tocopherol	278-567 ppm	TG51, Girnar-3, GJG18, Kadiri6, (TKG19A*, Kadiri Amravathi*, TLG45*

*at par value

7. Cultivation Practices Enhancing Peanut Quality

To harvest the best quality peanut, a total of 100 peanut cultivars were grown under high management condition by Plant Physiology section at the DGR Research farm in calcareous soil with 5 t FYM ha^{-1}, 40:50:50 kg N:P:K as DAP (diammonium phosphate) and MOP (muriate of potash), 1 kg Bha^{-1} as borax and 2 kg Zn ha^{-1} as zinc sulphate all applied 50 % as basal and 50 % at 50 days after emergence (DAE), 500 kg ha^{-1} gypsum applied at 50 DAE (Singh 1999; Singh and Chaudhari 2006, 2007) following standard package of practices, without using any pesticides. The produce was harvested at maturity, dried in sun to 7% moisture content, pod yield was recorded and subjected to estimation of various quality parameters (oil, protein, sugars, phenols and FAA) given in appendix III (Singh et al 2020) . The pod yield ranged from 750-2600 kg ha^{-1} with an average yield of 1650 kg ha^{-1}.

The oil contents varied from 42.7 to 52.8% with an average value of 47% and there were about 15 cultivars which showed high oil (>50 %) which can be used exclusively for oil extraction. Similarly, there were a 17 cultivars low in oil with less than 45% oil which can be used as food. The protein contents varied from 25.1 to 35.4 % with an average value of 31.8% with 15 cultivars were high in protein with >34% protein. Coincidentally most of the high protein containing cultivars are low in oil content. The sugar contents varied from 3.76 to 6.91% with an average value of 5.25% and there were 20 cultivars showing more than 6% sugar. The phenol contents varied from 0.21-0.30% with an average value of 0.27%. The FAA contents varied from 0.64 to 0.81% with an average value of 0.73%.

In North India, under Delhi conditions a number of peanut cultivars evaluated showed variation to the extent of 910-2160 kg ha^{-1} with a mean value of 1480 kg ha^{-1} seed yield, 24.5-59.4 and 40.4 g 100-seed weight, 53-87% and 67% shelling out turn, 20.8-28.9 and 26% protein and 39.6-49.1 and 47% oil contents in seeds (Singh et al 2010).

This degree of variation in seed yield and quality traits offer an opportunity to further evolve the promising peanut varieties to boost both the seed and oil production in the country.

8. Conclusions

- ✓ Peanut is a super food owing to its nutritive value and can act as a panacea for malnutrition.
- ✓ Utilization pattern of peanut has changed from oil to food and would continue to be the major source of nutrient rich food in India and other countries.
- ✓ With people becoming more and more conscious about healthy-eating, peanuts has become more popular as an important source of unsaturated fats, protein, vitamins, and minerals and its consumption will increase in near future.
- ✓ Bioactive compounds present in peanuts display a wide range of health benefits.
- ✓ Postharvest losses due to aflatoxin contamination and seed deterioration causes rancidity and storage pests related issues.
- ✓ The short shelf life of peanut products is another issue which need proper attention. needs to be addressed promptly.

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10. Appendix

Appendix I

Analytical Methods of Nutrient and Bioactive Components

Analyte	Method(s)	References
Moisture	Gravimetric using vacuum/Hot air oven	AOAC 934.01
Protein	Titrimetry by combustion/ Kjeldahl/Mixed catalyst	AOAC 2001.11; Jones (1941)
Ash	Gravimetric using Muffle furnace	AOAC 942.05
Fats	Gravimetry: Ether extraction using Soxhlet apparatus	AOAC 963.15
Energy Free sugars	Atwater conversion factors HPLC-RID	Merill & Watt (1973) AOAC 2013.12
Starch	Calculated from the increase in the amount of glucose by using conversion factor	Casterline et al (1998)
Oligosaccharides	HPLC	Frias et al 1994; Johansen et al 1996; Sanchez-Mata et al 1998
Micronutrients	AAS	AOAC968.08; AOAC 999.10; AOAC 999.11
Phosphorus	Colorimetry	AOAC 935.45; AOAC 995.11; Fiske & Subbarow 1925
Organic acids	HPLC	AOAC 969.30; AOAC 950.35; AOAC 948.14
Fatty acid profiles	GC with FID	AOAC996.06; AOAC 996.01; AOAC 2012.13
Polyphenols	HPLC	Sakakibara et al 2003
Phytates	Ion Exchange and Spectrophotometry	AOAC 986.11-1988

Yield and quality parameters of 100 Indian peanut cultivars grown under high management conditions in calcareous soil during *kharif* season at DGR, Junagadh, Gujarat

SN	Peanut cultivars	Pod yield (g m^{-2})	% Oil	% Protein	% Sugar	% Phenols	% FAA
1	TMV 2	146	45.9	33.3	5.85	0.28	0.735
2	SB XI	96	46.0	33.1	5.62	0.28	0.745
3	JL 24	95	47.1	32.1	5.45	0.26	0.735
4	KRG 1	128	49.8	29.4	4.40	0.27	0.765
5	GG 2	129	48.5	30.6	4.59	0.25	0.775
6	DHARANI	89	49.3	29.6	4.55	0.26	0.745
7	SG 84	120	51.0	27.8	3.82	0.25	0.775
8	ICGS 44	180	46.9	32.0	5.01	0.30	0.760
9	VRI 2	153	46.5	32.6	5.43	0.26	0.735
10	RARS-1	148	50.0	29.2	4.12	0.28	0.795
11	VRI8	170	46.7	32.5	5.38	0.29	0.750
12	TAG 24	153	46.2	32.9	5.25	0.29	0.765
13	ICGV 86590	178	46.3	32.7	5.20	0.30	0.760
14	DRG 12	123	45.8	33.3	5.45	0.29	0.750
15	KALAHASTI	75	48.8	30.3	4.62	0.29	0.760
16	SMRUTI (OG,52-1)	120	50.3	28.8	3.95	0.27	0.800
17	Tirupati 4	88	46.5	32.8	5.33	0.29	0.765
18	R 9251 (KRG 3)	99	50.5	28.8	3.94	0.25	0.800
19	JGN 3	151	47.2	32.0	4.99	0.27	0.775
20	GJG 32	151	50.4	28.9	4.09	0.27	0.770
21	K134	124	50.0	29.6	4.15	0.27	0.810
22	JL 220	116	51.7	27.4	3.76	0.25	0.785
23	CO 4	118	51.0	28.5	3.78	0.28	0.810
24	GG 7	130	50.1	29.3	4.07	0.27	0.800
25	AK 159	149	50.3	29.1	4.08	0.26	0.790
26	TPG 41	130	48.8	30.6	4.41	0.29	0.795
27	TG-37A	184	48.1	30.9	4.97	0.26	0.735
28	GPBD 4	124	48.8	30.5	4.63	0.27	0.770
29	TLG 45	143	49.9	29.1	4.12	0.26	0.780
30	SG 99	164	47.0	31.7	5.17	0.28	0.725
31	JL 286	103	46.9	32.3	5.32	0.27	0.745
32	DH 86	148	43.6	34.9	6.62	0.28	0.660
33	Kadiri 6	191	51.1	27.7	3.93	0.25	0.760

34	Pratap Mungphali 2	123	45.1	33.5	6.11	0.27	0.675
35	Pratap Mungphali 1	114	49.5	29.3	4.29	0.25	0.755
36	LGN 1	80	51.0	27.2	4.00	0.22	0.720
37	GG 8	126	46.8	31.9	5.33	0.25	0.705
38	TMV 13	126	48.5	30.1	4.86	0.22	0.715
39	DH 101	117	47.1	31.8	5.13	0.28	0.730
40	ICGV 91114	173	47.9	31.0	4.88	0.26	0.740
41	TG 51	144	47.0	32.1	5.10	0.27	0.750
42	Ajeya (R 2001-3)	176	46.8	31.9	5.40	0.26	0.710
43	VRI 6	125	45.5	33.2	5.74	0.27	0.705
44	JGN 23	182	46.7	32.1	5.36	0.25	0.720
45	Kadiri 9	152	52.8	25.1	3.82	0.22	0.695
46	JL 501	165	46.0	32.5	5.59	0.26	0.695
47	Vijetha (R 2001-2)	206	44.3	34.1	6.24	0.28	0.670
48	Girnar 3	181	45.9	32.7	5.54	0.28	0.715
49	Kadiri Harithandra	165	47.6	31.1	5.10	0.26	0.705
50	GPBD 5	158	47.4	31.6	5.02	0.28	0.735
51	ICGV 00350	190	49.4	29.6	4.41	0.26	0.750
52	GJG 31	130	47.6	31.5	5.03	0.26	0.745
53	GJG 9	171	50.0	28.6	4.31	0.24	0.74
54	Kopargaon 3	93	47.5	31.5	4.96	0.27	0.745
55	Gangapuri	125	46.2	32.7	5.46	0.26	0.725
56	TMV 10	134	47.9	31.2	4.96	0.28	0.735
57	Kaushal (G 201)	133	45.7	32.9	5.65	0.28	0.705
58	ICGS 76	188	45.9	32.8	5.59	0.28	0.710
59	GG 20	248	48.3	30.8	4.63	0.28	0.760
60	VRI 7	82	46.6	32.2	5.48	0.26	0.710
61	BAU 13	216	44.1	34.0	6.60	0.28	0.640
62	B 95	95	44.6	33.9	6.16	0.28	0.690
63	ICGV 86325	201	45.2	33.6	6.00	0.27	0.700
64	Kokan Gaurav	158	46.1	32.8	5.59	0.27	0.720
65	M 522	260	42.7	35.4	6.91	0.27	0.640
66	HNG 10	169	45.5	33.3	5.73	0.28	0.715
67	CSMG 884	224	44.1	34.3	6.39	0.28	0.670
68	LGN 2	195	43.5	34.9	6.80	0.27	0.650
69	GG 21	216	49.7	29.4	4.33	0.28	0.765

70	AK 265	248	46.1	32.5	5.83	0.27	0.680
71	AK 303	214	48.2	30.9	5.04	0.28	0.735
72	Girnar 2	158	45.3	33.4	5.75	0.29	0.720
73	ICGV 00348	151	52.7	25.3	3.77	0.21	0.700
74	Kadiri 7	221	47.0	32.1	5.44	0.26	0.735
75	Kadiri 8	197	45.7	33.4	6.04	0.26	0.705
76	Mallika	200	46.8	32.0	5.15	0.28	0.740
77	TGLPS 3	206	45.8	33.0	5.65	0.28	0.725
78	HNG 69	171	48.8	30.1	4.54	0.27	0.755
79	RG 425	241	44.6	33.8	6.07	0.28	0.690
80	HNG 123	155	45.7	33.3	5.68	0.28	0.725
81	CO 6 (ICGV 87846)	180	49.7	29.3	4.39	0.25	0.745
82	RG 578	163	47.1	31.3	5.10	0.29	0.720
83	GJG 22	234	48.0	30.9	4.98	0.28	0.740
84	RG 559-3	193	47.3	31.2	5.26	0.27	0.700
85	M 13	244	45.8	32.9	5.53	0.29	0.730
86	RG 382	203	42.9	35.1	6.77	0.28	0.645
87	M 197	195	45.8	33.0	5.65	0.28	0.715
88	RG 510	243	45.5	33.2	5.65	0.29	0.720
89	DSG 1	137	46.3	32.6	5.32	0.28	0.740
90	M 335	193	44.3	34.3	6.12	0.29	0.695
91	CSMG 84-1 (Ambar)	221	45.3	33.1	5.85	0.29	0.685
92	GG 14	205	44.1	34.3	6.27	0.29	0.685
93	CSMG 9510	241	45.9	32.8	5.62	0.29	0.710
94	GG 16	245	43.8	34.7	6.52	0.29	0.670
95	M 548	192	43.1	35.3	6.68	0.30	0.675
96	GJGHPS 1	185	47.1	31.9	5.17	0.28	0.735
97	CSMG 2003-19 (Divya)	224	43.5	34.5	6.59	0.28	0.640
98	GJG 17	208	43.4	35.0	6.62	0.28	0.665
99	GJG 18	219	43.0	35.1	6.83	0.28	0.635
100	GJG 19	217	43. 8	34.7	6.43	0.29	0.675
	Average	165	47.1	31.7	5.25	0.27	0.730
	Min	75	42.7	25.1	3.76	0.21	0.640
	Max	260	52.8	35.4	6.91	0.30	0.810
	SD	47	2.3	2.2	0.83	0.02	0.040

भाकृ अनुप-मूँगफली अनुसंधान निदेशालय

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