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Full Length Research Paper

Nutritional study of new variety of groundnut (*Arachis hypogaea* L.) JL-24 seeds

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Proximate composition, anti-nutritional and nutritional value of seeds of new variety of groundnut (*Arachis hypogaea* L) JL-24 was determined. The result showed that the groundnut seed contain moisture (5.529%), crude fibre (1.149%), lipid (46.224%), crude protein (25.20%), carbohydrate (21.26%), ash (2.577%), calcium (0.087%), phosphorus (0.29%) and energy (601.856%). The total fatty acid composition was 10.44 and 33.51% for saturated and unsaturated fatty acid, respectively. The protein solubility at different pH ranging from 0.5 to 13.5, the maximum seeds proteins were extracted at pH 12. The serine has not been reported in the seed protein and the seed was found to contain highest amount of proline (6.412%). The anti-nutritional analysis shows that cyanide content 4.818 HCN/100 g, tannin 0.412/100 g, oxalate 0.180/100g and haemagglutinin activity for goat blood group is 1:8 and no haemagglutinin activity for chicken and human blood group, and no trypsin inhibition was found. The nutritive values were determined in terms of feed utilization 6.552%, nitrogen utilization 0.2957%, protein efficiency ratio (PER) (+) 1.368% and feed efficiency ratio (FPR) (+) 0.345%. The knowledge of this study could be utilized for various food preparation and selection for breeding purpose.

Key word: *Arachis hypogaea* JL-24, chemical composition, nutritional and anti-nutritional composition.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is among the major oil seeds in the world. China, India and USA are the main producers of groundnuts to the rest of the world (Campos-mondragon et al., 2009). In India groundnuts are used mainly for oil extraction. JL 24 which is also known as Phule Pragati, was developed at Jalgoan, India and released for commercial cultivation for Maharashtra and Gujarat, India and is adapted all over India. It is an early maturing type with dark green leaves and is much preferred because of its bold seed and has maturity period of 90-95 days with smooth pods and pink kernels.

In 2003, the US food and drug administration reported that scientific evidence suggests that eating 1.5 ounces (43 g) per day of most nuts (including peanuts), as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease (Alper and mattes, 2003). Recently, it has been associated with metabolic benefits in the context of counteracting metabolic dysfunction associated with the increasing prevalence of obesity and metabolic syndrome (Coates and Howe, 2007).

Groundnut, (*Arachis hypogaea* L.) also known as peanut or earthnut is a native to a region in eastern South America (Weiss, 1983). Groundnut is now grown worldwide in the tropical and temperate zones primarily as an oil seed crop (Bansal et al., 1993). The fat content in groundnut has been largely studied. In general, groundnuts contain 50-55% fat of which approximately 30% is linoleic acid and 45% is oleic acid. High-oleic groundnuts rather than normal groundnuts have increased self life and thus improve the oxidative stability of peanut products (Isleib et al., 2006). Groundnut seed contain 44-56% oil and 22-30% protein on a dry seed basis and is a rich source of minerals (phosphorus, calcium, magnesium and potassium) and vitamins (E, K and B group) (Savage and Keenan, 1994).

The chemical composition of groundnut seed has been evaluated in relation to protein level (Young and

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Abbreviation: PER, Protein efficiency ratio; **FPR,** feed efficiency ratio; **GLC,** gas liquid chromatogram; **FID,** flame ionization detector; **HPLC,** high performance liquid chromatography.

Hammons, 1973), amino acid composition (Young et al., 1974) and fatty acid composition (Grosso and Guznam, 1993) in some cultivars. The nutritive value of food is high as the groundnut is affordable and serves as good source of oil and protein (Atasie et al., 2009).

The purpose of the present investigation was to determine protein, oil, fatty acid, carbohydrate, protein solubility, amino acid, anti nutritional factors and nutritive value of the *Arachis hypogaea* species which represent natural resources with potential economic for use in human and animal nutrition. It also shows the utilization of groundnut in India and suggests the future strategy for the plants breeder, nutritionist, health advisors and dieticians as to how to make best use of the groundnut.

MATERIALS AND METHODS

Seeds of groundnut (*Arachis hypogaea*) variety JL–24 were procured from Mahatma Phule Krishi Vidyapeeth, Jalgaon (Maharashtra),India, the originating institution, and the authentic source of genetically pure seeds of this variety.

Chemical composition

The groundnut seeds were cleaned and stored properly at room temperature prior to their use in actual experiment. Moisture, ash and calcium contents were determined by the methods described by Pearson (1962). Crude fibre content was determined by the method proposed by Pearson (1973). Phosphorus was determined according to the procedure of Sumner (1944). Carbohydrate, reducing and non reducing sugar were estimated by the method of Nelson (1944). Crude protein was estimated by "Micro Kjeldahl" method (N X 6.25).

Fatty acid composition

Powdered samples of experimental seeds where subjected to solvent extraction in Soxhlet apparatus for 20 h, using petroleum ether (40-60)0C as solvent. Lipids were then estimated gravimetrically by following of Colowick and Kaplan (1957). Methyl esters of the lipids were prepared by the method of Chowdhary et al (1984). The Gas Liquid Chromatogram (GLC) analyses were carried out using a CHEMITO gas chromatogram (Model no. 8610 GC) and gas chromatogram was recorded using Flame Ionization Detector (FID) with split ratio 1:50.

Protein solubility

In the present investigation all the seeds were analyzed for their protein content and protein solubilization with pH variation in the powdered form, because the powder size of seeds has been shown to influence nitrogenous extraction (Dijang et al., 1953, 1952). The seeds were sun dried and powdered to mesh (Deshmukh and Sohonei, 1965).

The effect of pH variation of the solvent on the protein solubilization was studied by varying pH of water, ranging from 0.5 to 13.5, brought by the addition of hydrochloric acid or sodium hydroxide solution, 1 gm of the seed powder was suspended in 20 ml of extractant of desired pH. The content were shaken in electrical shaker for about 2 h at room temperature and centrifuged for 20 min at 2000 rpm in a centrifuge. The nitrogen solubilized was determined in supernatant so obtained by "micro Kjeldahl" method (Pearson, 1973).

Amino acid profile

Amino acids were determined by high performance liquid chromatography (HPLC) by the methods of Cserhati and Forgacs (1999), Kerese (1984). Finely ground samples were hydrolyzed by adding 4.83 g Barium hydroxide and 5 ml of boiling water to 500 mg of sample. The mixture was evacuated and then heated at 120°C for 8 h. After hydrolysis, the pH was adjusted to 3 with HCl and diluted to 25 ml with HPLC grade distilled water. 1 ml of sample was vacuum dried using flash evaporator and finally dissolved in citrate buffer (0.1 m; pH 2.2).

Acid hydrolysis is carried out with 6 N HCl at 110°C for 18-22 h in evacuated and sealed tubes. The hydrolysate was filtered and diluted to 250 ml. 1 ml of sample was vacuum evaporated at 40°C until dryness. The content was dissolved in citrate buffer (0.1 M; pH 2.2). 20 µl of this derivatized were injected directly into the HPLC. Detection was accomplished using Shimadzu HPLC detector LC-10A with variable wavelength monitor set at 350-450 nm. Resolution of amino acid derivatives was routinely accomplished using a binary gradient system.

The solvent used were: (A) 58.8 gm of sodium citrate containing 0.2 N sodium (pH 3.2), 210 ml 99.5% ethanol and 50 ml (60%) perchloric acid and (B) 58.5 gm of sodium citrate containing 0.6 N sodium (pH 10), 12.4 g boric acid and 30 ml 4N NaOH solution. Solvent was delivered to the column at a flow rate of 4 ml/min for 7 to 10 min.

Anti-nutritive factors

Cyanide and Tannin were determined by the method of AOAC (1970). Oxalates were determined by using the method of Talpatra et al. (1984). Method of Kakade et al. (1969) was used for the determination of Trypsin inhibitor activity. Haemagglutanin activity was determined by the method as given by Liener (1955).

Nutritive value

The experimental diets were isonitrogenious (24.50%) and isocaloric (3030 Kcal/Kg). The balance diet comprised (per Kg) of: 420 g maize yellow, 50 g oil, 430 g groundnut cake, 80 g fish meal (Jawala), 19.6 g mineral mixture and 0.49 vitamin mixture as recommended by I.S.I. (Indian Standards Institution) (565.4 part I 1970). Casein and seed proteins were added to this balance diet by substitution of the maize yellow to give a total dietary protein content of 100 g/Kg. The seed meals used in the study were autoclaved for 30 min at 15 1b pressure (Kaduskar et al., 1978) before being incorporated in the diets to destroy the toxic constituents (Cyanogenitic glycosides, tannin and trypsin inhibitors). Crude protein content and other proximate constituent are not affected by autoclaving (Gupta et al., 1988) and protein digestibility is enhanced by four to forty percent as compared to raw material (Sangle et al., 1993).

The experiment was performed on the white male albino rats. Eighteen rats of aged 34 days old were distributed to six groups each having three rats. Rats selected were of body weight nearest to the mean of population. They were housed in individual cages. The rats were fed ad libitum exclusively experimental diets were fed for ten days (Bressiani et al., 1977) including the three days of pre experimental period and water was available ad libitum. The weight and food intake of the rats were monitored daily. Faeces were collected between days 5 and days 10 of the trial. The faecal (excreta) were dried in hot oven at 100°C. Protein efficiency ratio

Table 1. Proximate principles of air dried seeds of GROUNDNUT VARIETY JL-24 (gm / 100 gm).

S/N	Seeds	Moisture	Crude fibre	Total lipid	Crude protein	Total carbohydrate	Reducing sugar	Non-reducing sugar
1	*A. Hypogaea* JL – 24	5.529	1.149	46.224	25.20	21.26	2.90	18.36

*Each value is an average of three determinations.

Table 2. Minerals and ash content of air dried seeds of groundnut variety JL-24 (gm /100 gm).

S/N	Seeds	Ash	Water insoluble ash	Water soluble ash	Alkalinity of water soluble ash (%meq)	Acid insoluble ash	Acid soluble ash	Calcium content	Phosphorus content
1.	*A. Hypogaea* JL–24	2.577	0.325	2.252	8.821	0.997	1.638	0.087	0.29

*Each value is an average of three determinations.

Table 3. Energy of groundnut variety JL-24 in Kcal.

Energy	***Archis Hypogaea* JL - 24**
In Kcal	601 .856

*Each value is an average of three determinations.

and feed efficiency ratio were calculated by the method given by Osborne et al. (1919). Total nitrogen was estimated by "Semi-Micro Kjeldahl" method as usual (Pearson 1973).

RESULT AND DISCUSSION

Proximate analysis of groundnut variety JL-24 is shown in Tables 1, 2, and 3. Result obtained showed that the seeds contained 5.529% moisture, 1.149% crude fibre, 46.224% total lipid, 25.20% crude protein, 21.20% total carbohydrate, 2.577% total ash and 601.856 Kcal energy. The major portions of carbohydrate of the seed under study were present in non reducing form. These results are in agreement with other varieties of groundnut seeds (Cancalon, 1971; Gupta and Shrivastava, 2004; Kumar et al., 1992; Nagraj, 1995; Nollet et al., 1996; Salunkhe et al., 1992; Thakur et al., 2005).

The groundnut variety JL-24 also contained significant amount of important minerals. The phosphorus (0.29%) was higher than the calcium (0.087%) and which is in general accordance with other groundnut seeds (Cancalon, 1971; Gupta and Shrivastava, 2004; Kumar et al., 1992; Nagraj, 1995). Phosphorus is needed for bone growth, kidney function and cell growth. It also plays a role in maintaining the body acid-alkaline balance (Fallon, 2001). Calcium plays a significant role in photosynthesis, carbohydrate metabolism and nucleic acids (Russel, 1973).

The fatty acids composition of the groundnut seed oils is shown in Table 4. The most abundant fatty acids of groundnut seed oil were oleic (C18:1), linoleic (C18:2) and palmitic (C 16:0) which together composed about 88.35% of the total fatty acids. The major saturated fatty acid in groundnut seed oil was palmitic acid (6.20 percent); the main unsaturated fatty acids were oleic acid (16.28%) and linoleic acid (16.35%). Linoleic acid which is one of the most important polyunsaturated fatty acids in human food because of its prevention of distinct heart vascular diseases (Boelhouwer, 1983), in addition, the linoleic acid, once separated could be utilized for producing dyes, plastics and resins. The oleic/linoleic ratio is an important parameter in terms of oil stability, the higher the ratio the more stable the oil (Branch et al., 1990). These results are in agreement with other varieties of groundnut seeds (Nagraj et al., 2001; Atasie et al., 2009). The Protein content of groundnut variety JL-24 was found to be 25.20%. The results of protein

Table 4. Fatty acid composition of groundnut variety JL-24 (gm / 100 gm).

Fatty acids	Palmitic	Stear-ic	Archi-dic	Behen-ic	Lign-oceric	Palm-itoleic	Oleic	Linoleic	Linol-enic	Ecose-noic	Saturated	Un Saturated
Carbon Double Bond ratio	16 : 0	18 : 0	20 : 0	22:0	24 : 0	16 : 1	18 : 1	18 :2	18 : 3	20 : 1	-----	------
A. Hypogaea JL – 24	6.20	1.99	0.41	1.82	0.02	- - -	16.28	16.35	0.88	- - -	10. 44	33.51

*Each value is an average of three determinations.

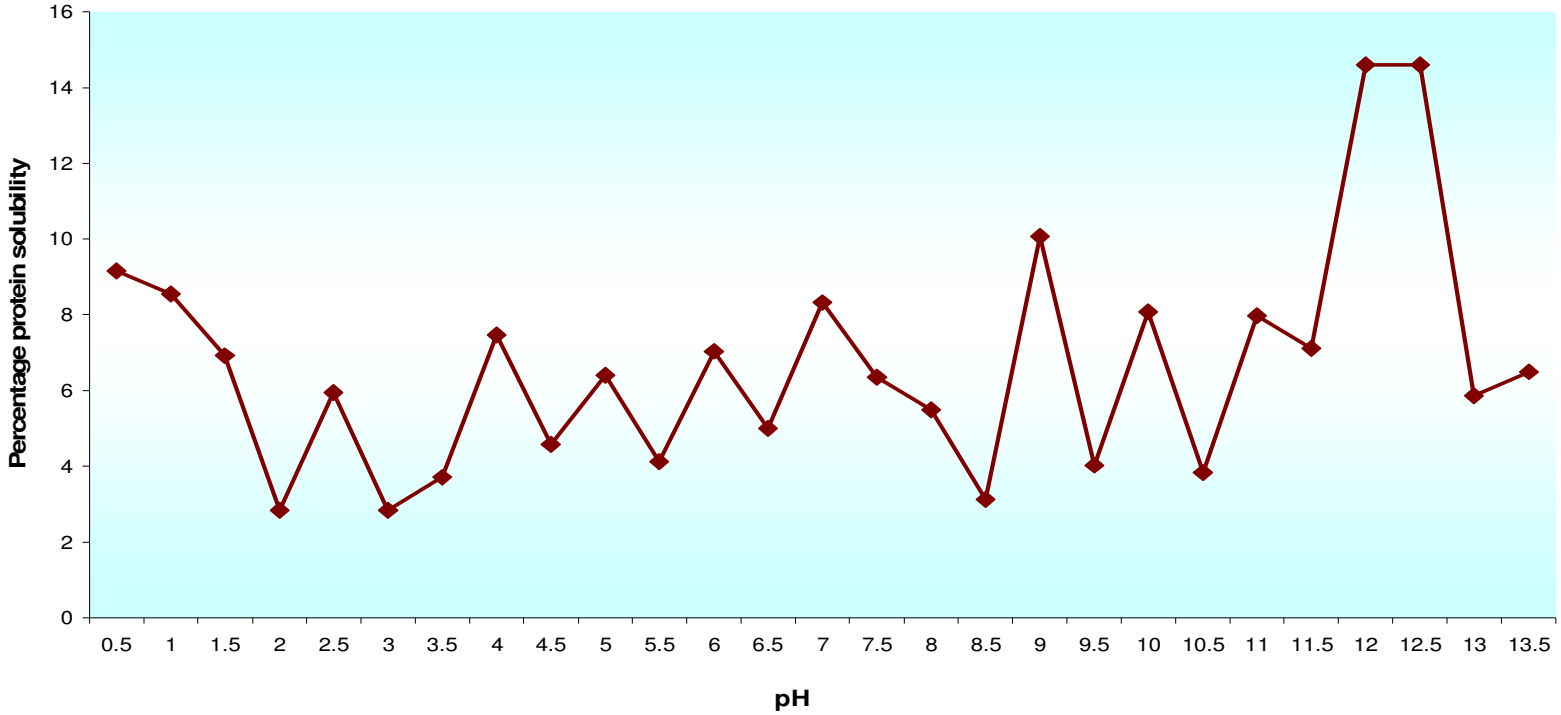

Figure 1. Effect of pH variation against solubility of seed protein of *Archis Hypogea,* JL-24.

solubility are represented graphically and in the tabular form (Figure 1 and in Table 5, respectively).The solubility of seed protein was found to be maximum (14.60%) at 12.0 pH and minimum (2.83%) at 2.0 and 3.0 pH. These results are in agreement with other groundnut and other oil seeds (Nagraj, 1995; Lah and Cheryan, 1980; Harsha et al., 1996; Singhai and Shrivastava, 2004; Wilson et al., 1965; Stevenson and Millet, 1959). The results of the Quantitative and qualitative estimation of amino acid composition of groundnut variety JL-24 are given

Table 5. Solubility of seed protein of groundnut variety JL-24.

pH	*Arachis Hypogaea* JL – 24
0.5	9.16
1	8.54
1.5	6.91
2	2.83
2.5	5.95
3	2.83
3.5	3.71
4	7.47
4.5	4.58
5	6.4
5.5	4.12
6	7.03
6.5	4.99
7	8.32
7.5	6.35
8	5.49
8.5	3.12
9	10.07
9.5	4.02
10	8.07
10.5	3.84
11	7.97
11.5	7.1
12	14.60
12.5	14.60
13	5.87
13.5	6.49

*Each value is an average of three determinations.

in Table 6 and chromatograms are represented in Figure 2. On the perusal of the data it appears that Serine has not been reported in the seed protein of JL- 24. Groundnut variety JL- 24 was found to contain highest amount of proline (6.412 g/100g). However, other amino acids are lying in between them in increasing order. Proline and its derivatives are often used as asymmetric catalysts in organic reactions. L-Proline is an osmoprotectant and therefore is used in many pharmaceutical, biotechnological applications. In brewing, proteins rich in proline combine with polyphenols to produce haze (turbidity).Aspartic acid deficiency decreases cellular energy and may likes be a factor in chronic fatigue (Amino acid, 2005). Glutamic and aspartic acids are considered essential amino acids by Reeds (2000). Arginine is associated with the cardiovascular system as a precursor to nitric oxide synthesis, which is an important blood pressure regulator (Lira and Arredondo, 2004).

The anti-nutritive factors of the groundnut seeds are shown in Table 7. The results shows that the values of cyanide content, tannin content and oxalate content are 4.818, 0.412 and 0.180/100 g, respectively. No inhibition of trypsin was found in groundnut variety JL- 24. Groundnut variety JL-24 has haemagglutinin activity for goat blood group is 1:8 and no haemagglutinin activity for chicken and human blood group was found. The results of present studies indicate low levels of anti-nutritive factors as compared to other varieties of groundnut seeds (Chubb, 1982; Dominguez et al., 1993; Gupta and Shrivastava, 2005; Nagraj, 1995; Montgomery 1969). The continuous exposure of HCN through diet may lead to pancreatic diabetes, Vitamin B12 deficiency and decreased uptake of iodine by thyroid glands which may further lead to goiter. Tannins are the oligomeric higher molecular weight polyphenolic compounds occurring naturally in plants. Due to their binding ability with protein and carbohydrates, tannins can inhibit digestive enzymes and reduce the bioavailability of different proteins (Muhammad et al., 2009).

Composition of experiment balance diets are given in Table 8. Feed intake denotes the food consumed in last three days. Feed intake, Faeces voided, Feed utilization, percentage of feed utilization, nitrogen utilization,

Table 6. Amino acid composition of groundnut variety JL-24.

Amino acids (g/100 g prot.)	*Arachis hypogaea* JL -24
Aspartic acid	3.459
Threonine	0.689
Serine	-
Glutamic acid	1.397
Proline	6.412
Glycine	1.232
Alanine	1.792
Cysteine	0.334
Valine	1.134
Methionine	0.243
Isoleucine	1.001
Leucine	1.622
Tyrosine	0.972
Phenylanine	1.266
Histidine	0.568
Lysine	0.929
Ammonia	0.494
Arginine	2.795
Tryptophan	0.306

*Each value is an average of three determinations.

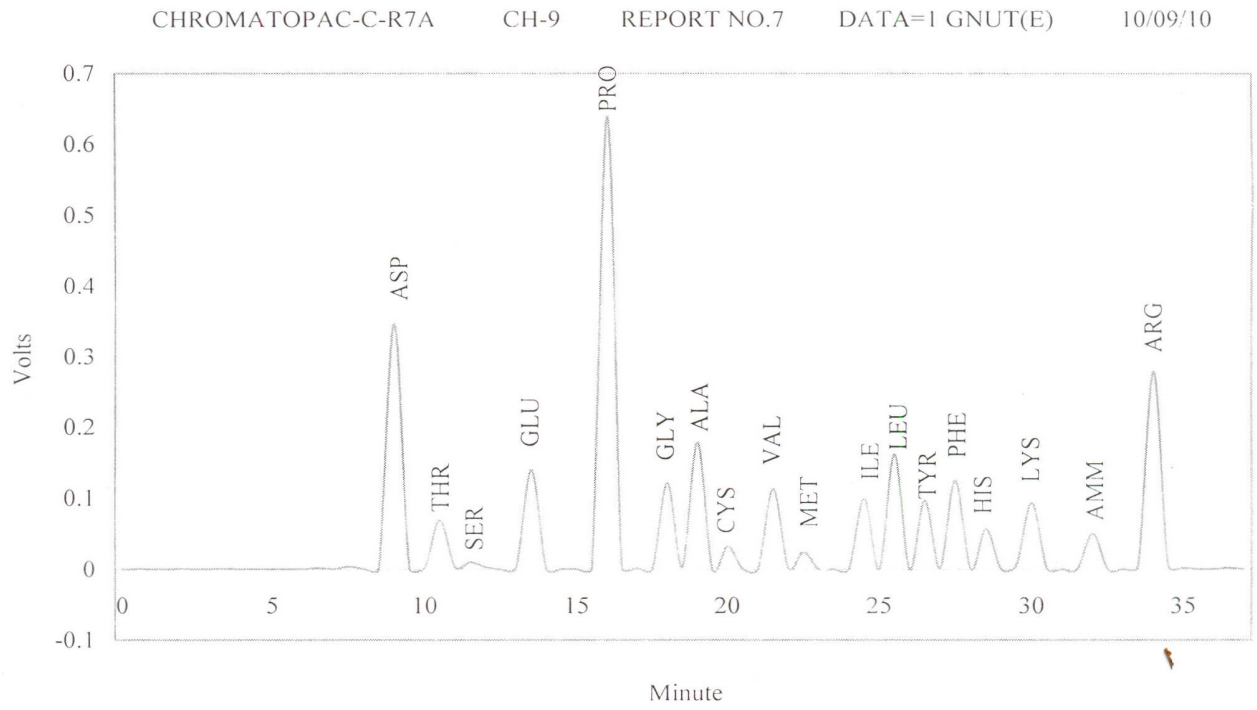

Figure 2. Chromatogram of Groundnut Variety JL-24.

nitrogen intake, nitrogen voided, nitrogen utilization, percentage of nitrogen utilization per rat per day are given in Table 9. Gain in body weight, total feed consumed, total protein consumed protein efficiency ratio and feed efficiency ratio per rat for ten days are given in Table 10. The feed utilization and nitrogen utilization for groundnut variety JL-24 was found to be 6.552 and 0.2957%, respectively. These values were found to be in

Table 7. Antinutritive factors in groundnut variety JL-24.

Oil seeds	Cyanide content (mg HCN/100 gm)	Tannin content (g/100 g)	Oxalate content (g/100 g)	Trypsin Inhibitor activity (TIA) percent inhibition	Haemagglutinin activity (on chicken blood group)	Haemagglutinin activity (on goat blood group)	Haemagglutinin activity (on human +O blood group)
A. hypogaea JL-24	4.818	0.412	0.180	ND	ND	1:8	ND

ND- not detected; *Each value is an average of three determinations.

Table 8. Composition of experimental diet g/kg and protein values percentage.

Diet ingredients	Balance diet	*A. Hypogaea* JL-24
Maize Yellow	420	380
Fat	50	70
Groundnut Cake	430	400
Oil seeds	-	50
Fish Meal (Jawala)	80	80
Mineral mixture	19.6	19.6
Vitamin mixture	0.4	0.4
Metabolic Energy	3053.06	3032.913
Calculated value of protein %	24.891%	24.556%
Analyzed value of protein %	25.21%	25.25%

Table 9. Feed intake, feed utilization, percentage feed utilization, nitrogen intake, nitrogen utilization, percentage nitrogen utilization / rat / day.

Diet of selected samples	Feed intake (g)	Faeces voided (g)	Feed utilization (g)	Percent feed utilization (g)	Nitrogen intake (g)	Nitrogen voided (g)	Nitrogen utilization (g)	Percent nitrogen utilization (g)
Balanced Diet	7.872	1.621	6.521	79.41	0.317	0.0337	0.2833	89.37
Arachis hypogaea JL-24	8.028	1.476	6.552	81.61	0.324	0.0283	0.2957	91.27

*Each value is an average of three determinations.

Table 10. Gain in body weight, total protein consumed, protein efficiency ratio (PER) feed efficiency ratio (FER) /rat/10 days.

Diet of selected samples	Protein in diet (g)	Gain in body weight (g)	Total feed consumed %	Total protein consumed	PER	FER
Balanced Diet	25.21	26.906	78.724	19.85	(+) 1.355	(+) 0.342
Arachis hypogaea *JL-24*	25.25	27.734	80.281	20.27	(+) 1.368	(+) 0.345

*Each value is an average of three determinations.

close resemblance with the values of feed utilization (6.521 g) and nitrogen utilization (0.2833 g) of controlled diet and also with other groundnut seeds (Gupta and Shrivastava, 2003; Nagraj, 1995; Singh et al., 2000; Gopalan, 1980; Shrivastava et al., 1991). The protein efficiency ratio of groundnut variety JL-24 was found to be (+) 1.368 and in general accordance with controlled diet (+ 1.355). This study showed almost same nutritive value with other varieties in spite of having different chemical composition. It may be due to isonitrogeneous inclusion of crude protein of groundnut seeds (Shrivastava et al., 1991).

The experimental results (means) were analyzed by triplicate determination.

Conclusion

The results of the study suggested that groundnut varieties have good nutritional attributes. The high energy, protein and carbohydrate contents suggest that groundnut could be of great importance in alleviating protein energy malnutrition. The minerals analyzed in groundnut were similar to those of other popular groundnut consumed globally, the good levels of fatty acids and some essential and non essential amino acids which make them a healthy food for human and animal nutrition. The low levels of anti-nutrients could enhance absorption of nutrient in groundnut.

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