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Research Article

Physicochemical and Processing Characteristics of Peanut

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Abstract: The aim of this study is to analysis the characteristics of peanut. Peanut occupies a unique position among oilseeds as it can be processed to peanut butter, oil and other products and can be consumed directly as well. In the present work, 66 peanut cultivars were characterized in respect to their physicochemical and processing characteristic. Results showed that Oleic was the major fatty acid varying between 32.83% in Haihuasheng and 48.80% in Huayu 19, followed by linoleic, palmitic and stearic acids which were 35.62±3.38%, 12.90±1.04% and 3.78±2.21%. The contents of arginine in peanut were 1.7 times to rapeseed, 2.6 times to wheat, 2.4 times to corn which ranged from 2.38g/100g to a high of 4.60g/100g. The arachin/conarachin ratio ranged from 0.87 to 1.68 with the mean values of 1.30±0.20. These data provide a starting point for establishing nutrient composition within these accessions and provide an early indication of currently important characteristics in these varieties which might be suited for use in random breeding initiatives.

Keywords: Chemical properties, peanut, physical properties, processing properties

INTRODUCTION

Peanut (*Arachishypogaea*L.) is one of the world's principal oilseed crops which is an annual legume grown in more than 100 countries around the world. Due to their organoleptic and nutritional values, high energy value, high protein content, low cholesterol nature and presence of some of the essential vitamins and minerals, peanut are consumed all over the world, not only as oil but also in a diversity of manufactured food products, such as snacks, butter and other dessert formulations. Several authors have published data on the general chemical composition of peanut (Özcan, 2010) and particularly on lipid and protein composition of peanut varieties cultivated in USA, India, Canada and China (Wang *et al*., 2009) and also the phospholipid profile, tocopherol and phytosterol contents were obtained in peanut varieties (Shin *et al*., 2010a, 2010b). Shin *et al*. (2010b) found that the fatty acid compositions of Runner peanuts were significantly ($p<0.05$) different among the normal, mid- and high-oleic peanuts investigated. Özcan (2010) reported that the oil yields from these kernels they studied vary from 32.7 to 45.4%, while the content of protein ranged from 25.9 % to 32.4%. Shin *et al*. (2010b) found that Oleic acid-to-linoleic acid (O/L) ratios were 1.93±0.30, 5.25±1.12 and 16.9±5.20 for normal, mid- and high-oleic peanut lipids, respectively.

Some varieties have been selected because of their high content of protein, oil and other chemicals. For example, TG 31 is an advanced breeding line developed at Babha Atomic Research Centre (BARC), Trombay having high protein and sugar content, J 11 is a Spanish type high yielding small-seeded (36 g HSW) variety released in 1964 for cultivation in Gujarat, India but had wider adaptability. It is a widely grown cultivar in western and central India and is resistant to seed infection and seed colonization by Aspergillusflavus. ICGV 86325 is a high yielding Virginia bunch type variety developed at ICRISAT and released in the year 1994, having small seed size (35 g HSW), tolerance to rust, late leaf spot and PBND (Hariprasanna *et al*., 2008). Despite the long history of global cultivation and ready consumer acceptance of peanuts, data on peanut whole quality are limited. Wang *et al*. (2009) researched on the fatty acids of 83 varieties. Young *et al*. (1973) studied on 16 peanut varieties found that the content of protein was 24% to 30%. Five peanuts were used to study the content of free amino and free sugar (Oupadissakoon *et al*., 1980). Throughout the

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literature, reports indicate that the fatty acid and amino acid composition of peanut varies significantly by genotype/cultivar (Davis *et al*., 2008), geographic location of production and environment factors including temperature and other seasonal effects (Shin *et al*., 2010a).

In recent years, there is an increasing interest both in industry and scientific research in peanut because of its strong nutritional and functional properties. These properties are due to some substances, including some protein, fat, amino acids and some others. Consequently, development of genotypes having high protein potential coupled with appropriate fatty acids, amino acids and protein subunit characteristics is one of the important breeding objectives in peanut. At present there are more than 6,000 peanut varieties in China. Little information has been reported about the whole properties of peanuts in some regions and cultivars or about the processing characteristic in general. Although Wang *et al*. (2011) reported the contents of protein, oil, sucrose of different peanut varieties in China. Also, more detailed research on the nutritional composition and health promoting components, such as fatty acids, amino acids, will enhance our knowledge and appreciation for the use of peanut and its products in a variety of food and specialty products. All of these enable the assessment of the genetic variability of the peanut cultivars, which can then be correlated with their multiple quality and food processing properties.

The accessibility of improved peanuts varieties and the rapid acceptance by farmers, together with modification of production methods, require that compositional data on agricultural commodities, be updated in a timely manner to ensure that it is representative of the commodity. As our understanding of what role of fatty acids, amino acids play in the pathology of multiple diseases, lipid and protein composition data for new and emerging peanut genotypes introduced into the market is important. This data becomes even more significant to geneticists/biotechnolog-yists who are trying to determine the genetic pros and cons of present-day peanut varieties in an attempt to combine the best traits from cultivars, leading to the development of stronger, more resilient peanuts. The aim of this study was to analysis some physical and nutritional properties of peanut kernels collected from several locations of China. Our study, completed at the request of the peanut industry in China, was designed to reexamine and to update compositional information of peanuts, including the levels of key bioactive, grown in China. In our opinion, the strength of this research initiative lies in the care and detail that went into the sampling effort of peanut types and cultivars.

MATERIALS AND METHODS

Selection of plant materials: Sixty-six peanut samples were collected in 2014 from the following 10 provinces in China: Shandong, 30 varieties; Henan, 9 varieties; Hubei, 6 varieties; Guangdong, 6 varieties; Fujian, 5 varieties; Jiangsu, 5 varieties; Guangxi, 2 varieties; Jilin, 1 variety; Hunan 1 variety; and Hebei 1 variety. Kernels were transported to the laboratory in polypropylene bags and held at room temperature. They were cleaned in an air screen cleaner to remove all foreign, matter such as dust, dirt and immature and broken kernels were discarded as well. Their moisture content was measured on arrival.

Method:

The Physical properties: The Physical properties were evaluated by the sensory evaluation members. Every sample was evaluated three times. The score of the in-shelled shape of peanut and kernels shape about each grade was assigned as the method of Luan *et al*. (1986) which were shown in Table 1. The score of the color of testa about each grade was assigned as the method of Wan (2008) which were shown in Table 1. The weight of 100 kernels was determined by weighting method. The kernel ratio was analyzed according to GB/T 5499.

Chemical properties: Moisture, crude oil, crude protein, crude fibre, ash, amino acids, fatty acids were analyzed according to AOAC methods. Sugars were determined as described by Dubois *et al*. (1956). The contents of arachin, conarachin and their subunits were performed following the method of Laemmli (1970).

Moisture: An accurately weighted sample (~2g) was placed in an aluminum pan and dried in a previously heated vacuum oven 105°C to a constant weight (Official Method 925.40).

Protein: Micro-Kjeldahl method was used to determine total proteins. Briefly, 0.5 g sample was placed in a Kieldahl flask. A catalyst [mixture of 2.80g

Table 1: Score of shape of in-shelled peanut and shape of kernels

The shape of in-shelled peanut	Score	Shape of kernels	Score	Color of testa	Score
Qugunxing	1	Oval	1	Atropurpureus	1
Tuofengxing	2	Triangle	2	Fuchsia	2
Chuanzhuxing	3	Peach-shaped	3	Crimson	3
Putongxing	4	Conical	4	Red	4
Fengyaoxing	5	Cylindrical	5	Blush	5
Huluxing	6			Pink	6
Canjianxing	7			Red and white	7
Futouxing	8			Faint yellow	8

$CuSO_4$+3.20g K_2SO_4], few glass beads (to prevent sample bumping) and 10 mL H_2SO_4 (36N) were added to each sample. Sample digestion was done at 410°C for 90 min (until clear green solution was obtained which ensured complete oxidation of all organic matter). The digest was diluted with 45 mL of distilled water and the Kjeldahl flash was attached to the distillation unit. After adding 40 mL 10 N NaOH, sample distillation was done to collect released ammonia into a boric acid solution containing the indicators methylene blue and methyl red. Borate anion (proportional to the amount of nitrogen) was titrated with standardized 0.1 N H_2SO_4. A reagent blank was run simultaneously. Sample protein content was calculated using the following formula:

$$\text{Protein}(\%) = \frac{(ml H_2SO_4 \text{ for sample} - ml H_2SO_4 \text{ for blank}) \times \text{Normality of } H_2SO_4 \times 1.4007 \times 5.46}{\text{weight of sample}(g)}$$

Fat: Fat was quantified using AOAC Official Method 948.22. A known weight of the sample (~2 g) was defatted in a Soxhlet apparatus using petroleum ether (boiling point range 38.2~ 54.3°C) as the solvent for 3 h. Defatted samples were dried in a fume hood to remove petroleum ether and weighted until the sample in a constant weight:

$$Fat(\%) = \frac{\left[\text{Initial wt.of full fat flour}(g) - \text{final wt.of defatted flour}(g)\right]}{\text{Initial wt.of full fat flour}(g)} \times 100$$

Fiber: Crude fiber is loss on ignition of dried residue remaining after digestion of sample with 1.25% (w/v) H_2SO_4 and 1.25% (w/v) NaOH solutions under specific conditions (AOAC 935.53).

Ash: Accurately weighted sample (~0.1 g) was placed in a ceramic crucible (previously heated and cooled till constant weight obtained) and subjected to ash at 550°C in a muffle furnace until constant weight (Official Method 950.49).

Total sugars: A known weight of peanut sample (~ 20 mg) was added 1.5 ml 72% H_2SO_4 at room temperature for 3 h. Then 15 mL H_2O was added into it, in 100°C for 4 h. When the sample cooled in room temperature, 4N NaOH was added to adjust the pH of solution to neutral. Then the pH 7.0 0.2 M phosphate buffer was used to constant volume to 100 ml. Then 1 ml supernatant was added 1 mL 6.0% (w/v) phenol and 5ml H_2SO_4, after 25 min, assigned at 490 nm.

Amino Acid composition: Total amino acid composition of the sample was determined using an Amino Acid Analyzer (L-8900). Accurately weighed sample was hydrolyzed in 600 μL of 6 M HCl in the presence of nitrogen (18 h, 110°C). The sample was treated with a 2:2:1 v/v/v ethanol: triethylamine: water solution and dried. The dried sample was then treated with a 7:1:1:1 v/v/v/v ethanol: triethyllamine: water: PITC solution (99.9%) and held for 20 min at 25°C in a nitrogen atmosphere and dried. Tryptophan content was determined by the colormetric method (No. 3) of Spies and Chambers. Tryptophan was determined separately after alkaline hydrolysis by the method described by Hugli and Moore (1972). Methionine and cysteine were determined separately in each cultivar (50.0 mg samples) according to the performic acid procedure of Moore (1963).

Fatty Acid composition: Extracted lipids (~70 mg) were transferred to a Reacti-vial™ small reaction vial (5 mL, Therno Fisher Scientific, Rockford, IL) and the mass was accurately weighed. The lipids were hydrolysed with a transmethylation reagent consisting of 6% (v/v) concentrated H_2SO_4 in anhydrous CH_3OH containing ca. 10 mg of hydroquinone. 2 ml of the transmethylation reagent and a Reacti- vial ™ magnetic stirrer were added to each reaction vial, which was tightly capped, vortexed for 1 min and placed in Reacti- vial ™ aluminum block within a Reacti-Therm III™ Heating/Stirring Module (Thermo Fisher Scientific, Rockford, IL) at 65°C for 16 h. After derivatization, sample were removed and allowed to cool to room temperature. Next, 1 ml of deionised H_2O was added to each reaction vial, the solution was vortexed for 30 s and FAMEs were extracted 3×with 1.5mL of hexanes. The hexane layers were combined in a test tube (13×100 mm, Fisher Scientific) and the washed 2×with 1.5 mL of deionised H_2O. After the second wash, the hexane layer was transferred to a new test tube via a Pasteur pipette. Hexane was removed using the N-EVAP. The FAMEs were redissolved in 1.5 mL of CS2 and transferred to 2-mL wide-opening crimp top vials (Agilent Technologies, Wilmington, DE). Vials were capped with 11-m silver aluminum caps, clear PTFE/red rubber septa and then crimped with an electronic crimper (Agilent Technologies). An Agligent Technologies 6890 N Network gas chromatograph system (configuration: capillary split/splitless inlet with Electronic Pneumatic Control [EPC] and a Flame Ionization Detector [FID] with EPC, for packed and capillary column) equipped with a 7683 autosampler tray module, 7683B autoinjector module (Fig. 1) and GC ChemStation software (Rev. A0803 (847), Agilent) was employed for fatty acids analysis profiling (AOAC966.03).

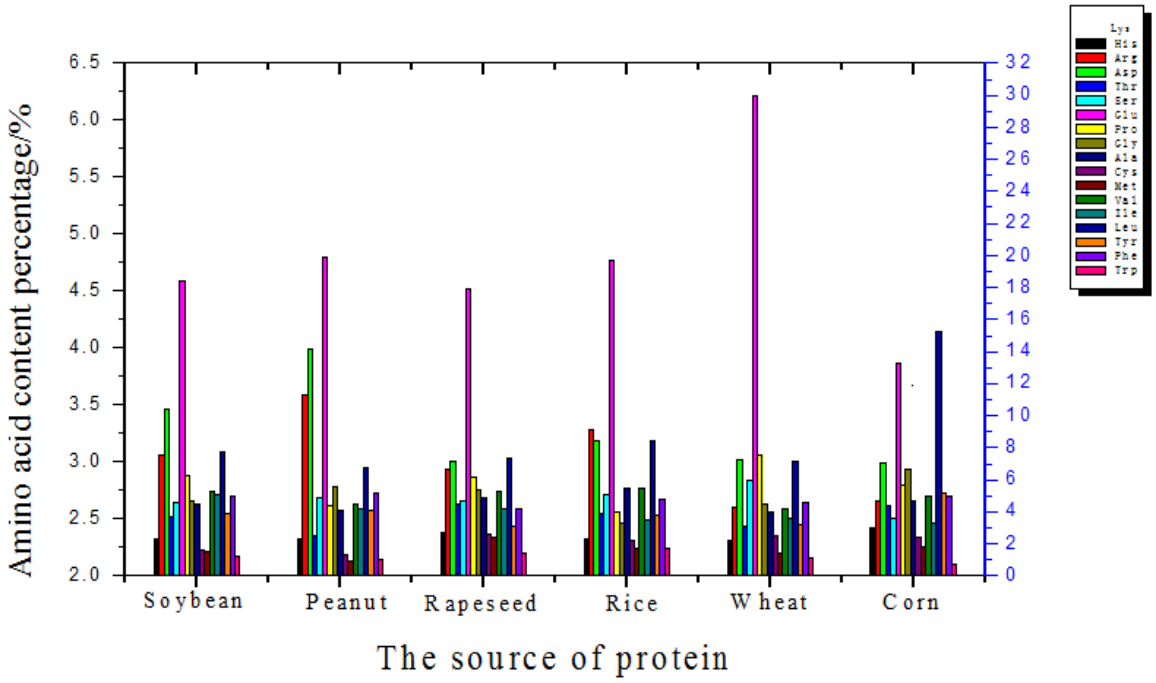

Fig. 1: Amino acid content of different raw materials

Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE): Ten milligrams of PPI was dispersed in 2 mL of 0.01 mol/L sodium phosphate buffer (pH 7.2) for 15 min with vortexing every 5 min. The extract was centrifuged for 10 min at 10,000 *g*. Then, we mixed 10 μL of extract with 10 μL of Tris buffer (pH 6.8), which contained 2% SDS, 10% glycerol, 5% β-mercaptoethanol and 0.002% bromophenol blue. The mixture was heated at 100ºC for 5 min, cooled to room temperature (25ºC) and used for SDS-PAGE. SDS-PAGE was performed following the method of Laemmli (1970) with some modifications to accommodate peanut protein. Protein samples (2.5 mg/mL) were prepared using SDS-PAGE in a vertical electrophoresis unit (Hoefer Scientific Instruments, San Francisco, CA) at 80 *V* constant voltages for 1 *h*, followed by 110 *V* constant voltages until the tracking dye migrated to the bottom edge of the gel (3 h). The gel slab was removed after the completion of electrophoresis. The gels were stained with Coomassie Brilliant Blue R-250 (*w/v*, 0.05%) in methanol-acetic acid-water (*v/v/v*, 25:10:65) and destained in the same solution without the dye. The gels were rinsed after destaining and the protein bands were analyzed using a densitometric approach. The electrophoretic patterns were analyzed using a transmittance/absorptance scanning densitometer (Alpha Innotech Chem., USA) with Alpha software. The relative protein quantity of each subunit (protein band) was calculated from their respective percent area on the densitograms against the total percent area.

Processing properties:

$$Kernel\ rate = \frac{The\ mass\ of\ shelled\ peanut}{The\ mass\ of\ inshell\ peanut} \times 100\%$$

$$protein\ extraction\ rate = \frac{the\ protein\ which\ were\ got}{Peanut\ protein\ content} \times 100\%$$

Statistical analysis: This research was performed by three replicates. Results of the research were analyzed for statistical significance by analysis of variance.

RESULTS AND DISCUSSION

The peanut quality included three aspects which were physical properties, chemical properties and processing properties. Although the aflatoxins are not an innate constituent of peanut kernels as they are produced by the fungus Aspergillusflavus. The peanut protein can cause allergic reactions in some individuals, which can range from abdominal discomfort to anaphylactic shock. The allergen, Peanut-I appears to be the most potent among allergens isolated from peanut. At present, however, peanut allergens are not considered a determinant of quality by the industry and the sensitive individuals are advised to eliminate peanuts from their diets (Misra, 2004). So the contents of aflatoxins, allergen and also the contents of heavy metal, pesticide did not include in this study. However, in the present exercise five physical (the shape of in-shelled peanut, shape of kernels, color of testa, the weight of 100 in-shelled peanut, the weight of 100 kernels), forty- six chemical (Moisture, crude protein

Table 2: Descriptive statistics for peanut sensory quality

Factor	Range	Mean	Variable coefficient/%	Upper quartile	Median	Lower quartile	Data variation /%
The shape of in-shelled peanut	1.00~8.00	5.07±1.86	36.78	4.000	5.000	7.00	1.38
Color of testa	1.00~9.00	5.47±1.46	26.62	5.000	6.000	6.000	9.690
Shape of kernels	1.00~5.00	2.40±1.79	74.54	1.000	1.000	5.000	58.33
The weight of 100 in-shelled peanut	114.80~285.00	183.07±43.42	23.72	149.5	183.5	213.8	0.230
The weight of 100 kernels	38.6~120	72.16±18.64	25.83	57.75	71.90	85.20	0.360

Table 3: Proximate composition of peanut quality

Factor	Range	Mean	Variable coefficient/%	Upper quartile	Median	Lower quartile	Data variation/%
Moisture	3.71~7.41	5.470±0.95	17.43	4.710	5.360	6.180	2.01
Crude fat	42.11~58.59	51.22±3.40	6.630	49.29	51.24	53.59	0.04
Crude protein	21.42~31.40	25.79±2.06	7.970	24.37	25.78	27.09	0.04
Total sugar	2.87~12.59	7.300±2.56	35.08	5.020	7.030	9.590	3. 70
Ash	2.19~3.46	2.570±0.20	7.860	2.450	2.560	2.650	0.39
Crude fibre	1.50~6.90	2.530±0.82	32.28	2.100	2.500	2.800	1.19

crude fat, total sugar, ash, crude fibre, total amino acids, 18 amino acids (asparaginic acid, threonine, serine, glutamic acid, proline and so on), total fatty acid, 13 fatty acids (myristic acid, palmitic acid, daturic acid, oleic acid, linoleic acid and so on); arachin (40.5 *kDa*, 37.5*kDa*, 35.5*kDa*、23.5*kDa*), conarachin (conarachin I, 18*kDa*、17*kDa*、15.5*kDa*; conarachin II,61 *kDa*) and five processing properties (Arachin/conarachin, oleic acid/ linoleic acid, the extraction of protein, kernel ratio) were identified as the determinants of quality.

How each of these properties ranged in different peanuts are discussed below.

Physical properties: The range, average, variable coefficient, upper quartile, median, lower quartile and data variation of the shape of in-shelled peanut, color of testa, shape of kernels, the weight of 100 in-shelled peanut and the weight of 100 kernels in the 66 peanut varieties are listed in Table 2. From the physical properties, the weight of 100 in-shelled peanut had the highest range, Zhenzhuhong was the smallest (114.80 g), Fenghua 5 was the largest (285.00g) with a mean of (183.07±43.42) g seeds. The shape of in-shelled peanut ranged from (1, Qugunxiing) to (8, Futouxing) with a mean of (5.07±1.86). The color of testa ranged from (1, Atropurpureus) to (8, Faint yellow). The shape of kernels varied from (1, Oval) to (5, Cylindrical) with the mean being (2.40±1.79). The weight of 100 kernels ranged from (38.60 g, Zhenzhuhong) to (120.00 g, Bianhua 3). The coefficients of variation for the shape of in-shelled peanut, color of testa, shape of kernels, the weight of 100 in-shelled peanut, the weight of 100 kernels 36.78, 26.62, 74.54, 23.72 and 25.83%, respectively.

Proximate composition: The moisture, crude protein, crude fat, crude fibre, ash, total sugar about the 66 peanuts is summarized in Table 3.

As expected, the seeds had low moisture content (ranging from 3.71% for "Huayu 23" to 7.41% for "Shanyou 250"). Low moisture content is important for keeping quality and shelf life of seeds as low moisture (and low A_w) decreases the probability of microbial growth, unwarranted fermentation, premature seed germination and many undesirable biochemical changes normally associated with these processes. Moisture content results of the present investigations are consistent with reported moisture contents for peanuts (Venkatachalam and Sathe, 2006).

Peanut are characterized by high oil and protein contents and low carbohydrates and ash. Knowledge of these components is important in the end products of the industry (Ahmed and Young, 1982). The highest oil, protein, total sugar, ash and crude fibre contents were Yuhua 9327 (58.59%), Longhua 243 (31.4%), Fenghua 5 (12.59%), Kainong 37 (3.46%) and Huayu 28 (6.9%.), respectively. The oil, protein content ranged from 42.11 to 58.59%, 21.42 to 31.40%, respectively. The variation range of oil content, protein content was broad to those of Grosso *et al*. (2000), who reported oil and protein values ranging from 45.7 to 51.8% and 25.0% to 30.1%. The present data, however, are considerably lower than those protein content reported by Özcan (2010), who have reported peanut protein contents ranged from 25.9 to 32.4 and 25 to 32%, respectively. The highest sugar content (12.59%) was found in Fenghua 5 and the lowest (2.87%) in Yuanhua 8. The former was a selection from Shandong, while the latter was collected from Jiangsu. At the same time, the content of sugar was lower than Grosso *et al*. (1997) reported, in their study the content of sugar ranged from 8.6 to 21.6%. The ash ranged from 2.19% to 3.46%. The ash was higher than Grosso *et al*. (1997) who reported that the content of ash was ranged from 2.3 to 2.9%.

Amino acid: Results of the amino acid analyses carried out on 66 peanut cultivars are summarized in Table 4.

Table 4: Amino acid composition of peanut varieties (g/100g of peanut)

Factor	Range	Mean	Variable coefficient
Total amino acid	19.08~38.41	26.34±4.36	16.56
Aspartic Acid	2.22~4.58	3.06±0.54	17.58
Threonine	0.40~0.97	0.70±0.12	17.73
Serine	0.81~1.88	1.24±0.25	20.02
Glutaminic Acid	2.05~9.03	5.27±1.52	28.90
Proline	0.79~1.70	1.22±0.19	15.77
Glycine	1.11~2.20	1.52±.275	18.11
Alanine	0.00~1.46	0.91±0.33	36.70
Cystine	0.35~1.14	0.6830±0.21955	32.14
Valine	0.90~1.51	1.18±0.14	11.81
Methionine	0.09~0.71	0.32±0.12	36.37
Isoleucine	0.71~1.29	0.96±0.14	14.79
Leucine	1.28~2.57	1.76±0.30	16.86
Tyrosine	0.46~1.62	1.06±0.31	29.21
Phenylanine	0.80~2.07	1.48±0.22	14.78
Lysine	0.77~1.35	1.02±0.12	11.83
Histidine	0.47~0.92	0.65±0.11	16.31
Tryptophan	0.16~0.42	0.24±0.05	19.22
Arginine	2.38~4.60	3.12±0.46	14.90

Table 5: Fatty acid composition of peanut varieties (g/100g of total fatty acids)

Factor	Range	Mean	Variable coefficient
C14:0	0.00~0.06	0.03±0.02	64.10
C16:0	11.46~15.83	12.90±1.04	8.03
C16:1	0.29~5.98	1.52±1.28	84.22
C17:0	0.00~0.16	0.08±0.03	33.82
C17:1	0.00~0.26	0.04±0.05	133.19
C18:0	1.96~16.56	3.78±2.21	58.52
C18:1	32.83~48.80	39.32±4.36	11.10
C18:2	28.39~41.27	35.62±3.38	9.50
C18:3	0.22~8.98	2.33±1.88	80.62
C20:0	0.63~1.64	1.15±0.24	20.99
C20:1	0.45~1.03	0.73±0.14	18.99
C22:0	1.07~2.64	1.84±0.37	20.20
C24:0	0.00~1.16	0.68±0.30	43.74
SFA	17.77~32.73	20.45±2.36	11.55
UFA	67.27~82.23	79.55±2.36	2.97
MUFA	34.14~51.92	41.60±4.27	10.26
PUFA	29.19~44.47	37.95±3.81	10.05

Peanuts are known to be deficient in the essential amino acids, lysine, methionine and threonine (Sarwar *et al*., 1989). The range for lysine was a low of 0.77g/100g (Yuhua 9326) and a high of 1.35 g/100g (Xianghua 509-77). This result was high than Dean *et al*. (2009) who reported that the range of lysine was 0.49～1.08g/100g in US. Methionine ranged from a low of 0.09g/100g (Shanyou 250) to a high of 0.71 g/100g (Shanhua 7) which is the same with Dean *et al*. (2009) who reported that the Methionine ranging from 0.09～0.57 g/100g. Threonine ranged from 0.40 g/100g (Shanyou 250) to 0.97 g/100g (Xianghua 509-77). The purpose of this study was to compare the varieties within the confines of this selection. The analyses suggest there are some varieties that have potential for breeding increases in these amino acids that limit the nutritional of peanuts. However, in soybeans, it has been found that in many cases, improvements to protein content through breeding (Panthee *et al*., 2005). Arginine is a nonessential amino acid that is of interest due to its positive associations with vascular health (Moriguti *et al*., 2005). We compared the peanut with soybean, wheat, corn, rapeseed and rice about the contents of amino acids (Fig. 1), the results showed that arginine in peanut was significant higher than other crops. The contents of arginine in peanut was 1.7 times to rapeseed, 2.6 times to wheat, 2.4 times to corn. Peanuts are the source of arginine which was accorded with Andersen *et al*. (1998). This selection of samples was found to contain arginine over a range of 2.38 g/100g (Luhua 11) to a high of 4.60 g/100g (Xianghua 509-77). This result was higher than Dean *et al*. (2009). Minor and major differences in amino acids contents of peanut kernels could be probably due to differences in climatic conditions, soil structure and environmental temperature during maturation of peanut seeds, because the peanuts were selected from difference areas in China.

Fatty acid: The fatty acid composition is presented in Table 5. Myristic (C14:0), palmitic (C16:0), palmitoleic (C16:1), daturic (C17:0), heptadecenoic (C17:1), stearic (C18:0), oleic (C18:1), linoleic (C18:2), linolenic (C18:3), arachidic (C20:0), eicosenoic (C20:1), behenic

Table 6: Peanut protein component and their subunits

Factor	Range	Mean	Variable coefficient
Arachin	46.40~62.70	56.19±3.86	6.87
Conarchin	37.30~53.50	43.81±3.88	8.86
Conarachin Ⅰ	20.00~33.40	24.95±2.94	11.78
Conarachin Ⅱ	13.40~25.30	18.85±2.54	13.46
40.5 *kDa*	7.70~15.20	10.67±1.79	16.80
37.5 *kDa*	10.50~17.90	13.97±1.63	11.70
35.5 *kDa*	0.00~19.20	9.52±5.84	61.32
23.5 *kDa*	18.70~26.50	22.03±1.74	7.90
61 *kDa*	13.40~25.30	18.85±2.54	13.46
18 *kDa*	6.40~11.40	8.62±1.35	15.68
17 *kDa*	6.90~13.20	9.52	15.06
15.5*kDa*	3.70~11.90	6.82	19.85

(C22:0) and lignoceric (C24:0) acids were detected. The fatty acid composition of the peanut was consistent with the corresponding data in the USDA data bank (2006). All seeds contained predominantly monounsaturated fatty acids (MUFAs) plus polyunsaturated fatty acids (PUFAs) ranging from 67.27% for Heihuasheng to 82.23% for Longhua 243. The fatty acid composition varied widely among different varieties and often the occurrence of unusual fatty acids was characteristic for particular plant families (Aitzetmüller, 1993). The kernel of peanut also contained appreciable amounts of saturated fatty acids, especially palmitic (11.46～15.83%, mean 12.90±1.04%) and stearic acids (1.96～16.56%, mean 3.78±2.21%). Regardless of the seed type, oleic acid and linoleic acid were the predominant contributors toward the makeup of the MUFAs and PUFAs, respectively, as well as the total lipids in the seed. Oleic acids accounted for 32.83% (Heihuasheng) to 48.80% (Huayu 19), with a mean value of 39.32±4.36%, while linoeic acids ranged from 28.39 to 41.27%. Zhonghua8 (40.70%); Bianhua3 (38.15%); Fenghua5 (39.99%); Fenghua4 (41.27%) showed higher linoeic acid. While the other varieties showed higher oleic concentrations. This was the same with Grosso *et al*. (1997). However, the wide variation of the oleic and linoleic acid percentages was also in accord with Grosso *et al*. (2000). The inverse relationship between oleic and linolenic acids found in this study (r = -0.714, data were not shown) was also reported by Wakjira *et al*. (2004), suggesting the synthesis of oleic, linoleic and linolenic acids in descending order.

Arachin, Conarachin and their subunits: Protein contents of arachin, conarachin and their subunits are presented in Table 6. Arachin had polypeptides of approximately 20 *kDa*to 45 *kDa*. Conarachin II showed a major polypeptide at 61 *kDa*, whereas the protein of conarachin I consisted mainly of small molecular weight polypeptides. These results were similar with that obtained by other reports. The highest arachin content (62.70%) was found in Xuhua 5 and the lowest (46.40%) in Qinglan 8. The former was a selection from Jiangsu, while the latter was collected from Shandong. Among the arachin fractions, 35.5 *kDa* exhibited a significantly difference protein content compared to that of the other varieties. 16 varieties absent 35.5*kDa*subunit which included Shuangji 2, Yueyou 14, Minhua 9, Shanyou 250 and so on. Among the arachin fractions, Baihuasheng had the significant higher 35.5 *kDa* content of 19.2%. The content of Conarachin I ranged from 20.00 to 33.40% with the mean of 24.95±2.94%. The highest was Xianghua 509-77 (33.40%) which collected from Hunan, while the lowest was Huayu 22 (20.00%) which collected from Shandong.

Murphy *et al*. (1997) reported that the composition and conformation were responsible for soybean protein's functionality. Nakamura *et al*. (1984) found that differences in gel strength among glycinin fractions from various soybean genotypes were related to variations in the makeup of the acidic subunits. Yagasaki *et al*. (2000) reported that the gel hardness seems to depend mainly on glycinin content. It had been suggested that soymilks rich in glycinin have larger protein particles and form harder gels than soymilk containing low levels of glycinin. Among the glycinin subunits, group I and group IIb (A_3) significantly affect gel firmness while group IIa has a negative effect on tofu quality (Poysa *et al*., 2006). It has also been suggested that lack of the α′-subunit of β-conglycinin increases gel hardness compared to gels made with a complete subunit profile (Poysa *et al*., 2006). Gregová *et al*. (2012) found that the wheat protein subunit Glu-1A was correlated positively with improved dough strength as compared to subunit null. We had also researched that the arachin was inverse with gel property (r = -0.47), while conarachin I (r = 0.49) and conarachin II (r = 0.59) was positive with gel property (unpublished).

Processing property: O/L, SFA/UFA, Arachin/ Conarachin, kernel ratio, extraction of protein are presented in Table 7. Oleic-to-linoleic ratio (O/L) is indicator of peanut oil stability and shelf life. High O/L ratios suggest better stability, longer shelf life and higher quality of the oils (Ahmed and Young, 1982). The O/L ratio ranged from 0.84 to 1.72 with a mean

Table 7: Processing properties

Factor	Range	Mean	Variable coefficient/%
O/L	0.84~1.72	1.12±0.23	20.62
SFA/UFA	0.22~0.49	0.26±0.04	16.13
Arachin/Conarachin	0.87~1.68	1.30±0.20	15.03
Kernel ratio	50.31~79.94	69.87±5.52	7.90
Extraction of protein	59.51~96.25	76.77±7.47	9.73

value was 1.12±0.23. The result was higher than Grosso *et al*. (2000) who reported that the O/L ratio ranged between 0.65 (A. *appressipila*) and 1.38 (A. *villosa*). But lower than Dean *et al*. (2009) who reported that the range of the O/L ratios was from 1.07 to 3.47. The mean of O/L in this research was lower than Casini *et al*. (2003) who showed that O/L was 1.22±0.12, 1.31±0.009, respectively, while 1.18±0.11 by Grosso *et al*. (1994). The ratio of SFA/UFA was ranged from 0.22 to 0.49 with the mean value of 0.26±0.04.

The arachin/conarachin ratios ranged from 0.87 to 1.68 with the mean values of 1.30±0.20. Kwanyuen *et al*. (1998) reported that soy protein functionality was partly dependent on the β-conglycinin-to- glycinin ratio, which can vary among genotypes. Nik *et al*. (2011) confirmed that the ratio of glycinin/β-conglycinin has a significant effect on gel structure, with an increase in glycinin causing an increase in gel stiffness. Utsumi *et al*. (1997) found the ratio of glycinin to β-conglycinin as well as their subunit composition varies among cultivars thereby affecting the processing properties of soy proteins. Kohyama and Nishinari (1993) reported that the differences in the ratio between glycinin and β-conglycinin cause differences in texture.

The variations observed between the results of this study could be probably due to differences in climatic conditions, soil structure and environmental temperature during maturation of peanut seeds. These findings may be useful for dietary information, which requires prior knowledge of the nutritional composition of nuts. The high oil and protein contents suggest that this kernel can be of use in the food industry.

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