Food Science and Quality Management
ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online)
Vol.37, 2015

Comparison of Proximate Composition of Some Cultivars of Chickpea (Cicer arietinum L.) Cultivated in Owerri, Imo State, Nigeria

Ngozi O. Kabuo[1*] Sunday A. Dialoke[2] Gloria C. Omeire[1] Evelyn N. Bedi[1] Ann I. Peter-Ikechukwu[1] ThankGod E. Irekpita[1]

1.Department of Food Science and Technology, Federal University of Technology, PMB 1526, Owerri Imo State, Nigeria

2.Department of Crop Science and Technology (School of Agriculture and Agricultural Technology), Federal University of Technology PMB 1526, Owerri Imo State, Nigeria

*Corresponding author: ookabuo@yahoo.com

Abstract

The proximate composition of some cultivars of chickpea grown in Department of Crop Science and Technology, Postgraduate Teaching and Research farm Federal University of Technology, Owerri (FUTO was investigated and compared. Two chickpea types namely Kabuli (ICCK 7323 and ICCK 9895) and Desi (cultivars ICCD 867, ICCD 12866, ICCD 8522, and ICCD 9586) were used in the work. The chickpea seeds were respectively crushed into meal and analyzed for Moisture, Protein, Fat, Fibre, Ash, Carbohydrate and Energy value using standard methods. Statistical analysis of the data was carried out using the Duncan New Multiple Test at ($p<0.05$). The proximate composition of all the chickpea cultivars were significantly ($p<0.05$) different from each other. The ranges were protein (12.72% to 19.46%); Ash ((3.05% to 10.85%), Energy value (345.6kcal/g to 450.67kcal/g) and Carbohydrate (8.81% to 39.80%). Cultivar ICCK7323 (Kabuli-type) had the highest protein content (19.46%), and cultivar ICCD867 (Desi-type) had the highest crude fibre (11.18%) and ash (10.85%) content respectively. Similarly, cultivar ICCK9895 (Kabuli-type) had the highest carbohydrate content (39.80%) while cultivar ICCD12866 (Desi-type) had the highest energy value (450.67kcal/g). Results show that chickpea cultivars (Kabuli-type) had higher values in protein, crude fibre, and carbohydrate, while cultivars (Desi-type) had higher values in fat, ash and energy.

Keywords: Chickpea, cultivars, proximate composition, sensory comparison

Introduction

Legumes are recognized as a major source of dietary protein and energy in the developing countries where cost of animal protein is very expensive. Out of many species of legume in plant kingdom only very few are consumed as food namely Cowpea, groundnut, bambara groundnut, soybean, pigeon pea, guinea pea, African yam bean, ground bean, and chickpea. However, some of these legumes are underutilized. The low consumption or under-utilization of some of these legumes are likely due to hard-to-cook characteristic of legumes, lack of information regarding their nutritive values, presence of anti-nutrients in the legumes, taboos and cultural beliefs, and low production. The problem chickpea is facing in Nigeria is that basic studies on the crop are limited and it is adapted to relatively cool climate and they are susceptible to insect pests especially pod borers, *Helicoverpa armigera* Hubner, *Maruca vitrata* Fab. Etc. (Dialoke et al., 2014) and also to drought, heat, cold, and salinity. Smithson et al., (1985) also reported infestation by insect pests particularly pod borers (*Helicoverpa armigera* Hubner) as the most important constraints to chickpea production in tropics and subtropics of Asia. The compositional evaluation of commonly consumed legumes have been reported by several workers (Elegbede, 1998, Onwuliri and Obu ,2002).

Chickpea (*Cicer areitinum L.*) is one of the lesser known and under-utilized legume indigenous to West Africa. It is a member of the family *Fabaceae* and sub-family *Faboideas*, it is a cool season legume crop and it is grown in several countries worldwide as a food source. The seed is the main edible part of the plant and it is a rich source of protein, carbohydrates and minerals especially for vegetarian population (FAO, 2008). As in case of other legume crops, chick pea can fix atmospheric nitrogen through its symbiotic association with *Rhizobium spp*, thus helping in enhancing the soil quality for subsequent cereal crop cultivation (FAO, 2008). Chickpea is the third most important food legume crop and India is the largest producer contributing to 65% of the world's chick pea production (FAO, 2008).

Even though India is the largest producer of chickpea, it still imports chickpea from other countries because, of the food value. Keeping in view, the ever-increasing demand for this legume crops, it is essential to improve the production and area under cultivation and at the same time minimizing the stress on this crop plant. There are two types of chick pea that are recognized, the white seeded "Kabuli' and the brown colored "Desi" types.

Kabuli chickpea are relatively bigger in size, having thinner seed coat while the Desi type seeds are

relatively smaller in size, having a thicker seed coat. The Desi type chick pea contributes around 20% of the total production. (Pittaway et al., 2008).

Chickpea is being used increasingly as a substitute for animal protein. As it is also a good source of zinc, folate and protein. The seeds are also very high in dietary fibre and hence, a healthy source of carbohydrate for persons with insulin sensitivity or diabetes. They are low in fat and the fatty acids are polyunsaturated (Pittaway et al., 2008).

Medicinal application include: use for aphrodisiac, bronchitis, cholera, constipation, diarrhea, dyspepsia, flatulence, snakebite, sunstroke and warts. Acids are supposed to lower the blood cholesterol levels (Duke, 1981).

However, the utilization of chickpea in Nigeria is limited because it is not a crop commonly grown in Nigeria. The objective of this research work is mainly to compare the proximate compositions on some cultivars of chickpea in order to know their nutrient values and compositions. This will encourage the cultivation of the crop for food in Nigeria. Also, more research work in agriculture for adaptability, hybridization and researches to enhance higher yield of the crop will be encouraged. Also, the processing of the crop into value addition products will continue to be carried out. The success of this work will be a step to create food cultivars, healthier living and food security for Nigerians.

Materials and Methods

Raw material, equipment and chemical procurement

The chickpea seeds used in this research were obtained from the Department of Crop Science and Technology seed bank, Federal University of Technology, Owerri, Imo State, Nigeria. All the chemical/reagents used in this work were of analytical grade, and the instruments/equipment were obtained from the Department of Food Science and Technology Laboratory, Federal University of Technology, Owerri, Imo state, which was where the entire laboratory work was carried out.

Proximate analysis: The association of Official Analytical Chemist (A.O.A.C.,1995) procedure were used to determine the proximate compositions of the chickpea samples.

Determination of moisture content: Two (2) grams of each of the samples were weighed out with the aid of an analytical balance into dried, cooled and weighed in each case. The samples were placed in oven set at 105^0c and allowed to dry for 3 hours. When this time elapsed, the samples were then transferred into a desiccator with the aid of a laboratory tong and then allowed to cool for 30 minutes. After cooling in the desiccator, they were weighed again and their respective weights recorded accordingly. The above processes were repeated for each sample until a constant weight was obtained in each case. The difference in weight was calculated as a percentage of the original sample.

$$\text{Percentage moisture content} = \frac{W_2 - W_3}{W_1} \times \frac{100}{1}$$

Where W_1 = Initial weight of the empty dish

W_2 = Weight of the dish + undried sample

W_3 = Weight of the dried + dried sample

Determination of ash content: Two (2) grams of each of the samples were weighed out with the aid of an analytical balance into a dried cooled and weighed crucible in each case. The samples were then charred by placing them on a Bunsen flame inside a fume cupboard to drive off most of the smoke for 30 minutes. The samples were thereafter transferred into a pre-heated muffle furnace already at 550 ^{0}C with the aid of a laboratory tong. They were allowed to stay in the furnace for 3 hours until a white or light grey ash resulted.

After ashing, the crucibles were transferred into a desiccator with a laboratory tong. When they were cooled, they were each weighed again and recorded accordingly.

$$\text{Percentage ash content} = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1}$$

Where W_1 = Weight of the empty crucibles

W_2 = Weight of crucible + sample before ashing

W_3 = Weight of crucible + ash.

Determination of crude fibre content: Two (2) grams of the samples were defatted (fat analysis) were used in this determination. The defatted samples were each boiled in a 500ml flask containing 200 ml of 1.25 % of H_2SO_4 solution under reflux for 30 minutes. When this time elapsed, the samples were washed with several portion of hot boiling water using a two–fold muslin cloth to trap the residual particles. The residual particles in each case carefully transferred qualitatively back to the flasks and 200 ml of 1.25 % NaOH solution was then added into each flask.

Again, the samples were boiled for 30 minutes and washed as before with hot water. Then, they were each carefully transferred into a weighed crucible and then dried in a Genlab oven set at 105 ^{0}C for 3hours.

The dried samples were then transferred into a desiccator where they were cooled for about 20 minutes before

being weighed again. After weighing, they were transferred into a muffle furnace set at 550 ^{0}C for 2 hours (until they were ashed).
Finally, they were cooled in a desiccator and weighed again. The crude fibre content for each sample was calculated thus;

$$\text{Percentage crude fiber content} = \frac{W_2 - W_3}{W_1} \times \frac{100}{1}$$

Where W_2 = Weight of crucible + sample after washing and drying in the oven.
W_3 = Weight of crucible + sample as ash
W_3 = Weight of the original sample.

Determination of crude protein content: Half a gram 0.5 g of each of the samples was mixed with 10ml of concentrated H_2SO_4 in a kjedahl digestion flask. A tablet of selenium catalyst was added to each of the sample which was then digested (heated) inside a fume cupboard until a clear solution was obtained in a separate flask in each case. Also, a blank was made by digesting the above reagents without any sample in it. Then, all digests were carefully transferred into a 100ml volumetric flask in each case and were made up to with distilled water. A 100 ml portion of each digest was mixed with equal volume of 45 % NaOH solution in a Kjedahl distilling unit. The resulted mixtures were each distilled and the distillates collected in each case into 10ml 0f 4 % boric acid solution containing three drops of mixed indicators (bromocresol green and methyl red). A total of 50 ml of each distillate was obtained and titrated with 0.02 molar H_2SO_4 solutions. Titration was done from the initial green colour to a deep red end – point.
The nitrogen content of each sample was calculated thus;

$$\text{Percentage crude protein content} = \frac{Vf\text{-}Va\ (W \times 14 \times 6.25)T}{W} \times \frac{100}{}$$

$$= \frac{T(w \times 0.0014 \times 6.25}{w} \times \frac{100}{}$$

Where W = Weight of sample analyzed
Vf = Titre volume of distillate
Va = Titre Volume of blank
T = Titer volume of the distillate minus titer value of blank with the factor 6.25 to obtain the crude protein content of each sample. I ml of 0.5N H_2SO4 =0.0014g

Determination of fat content
Two hundred and fifty millilitres (250 ml) of boiling flasks (volumetric flasks) were washed with water, dried in Genlab oven set at 105 ^{0}C for 30 minutes, cooled in a desiccator and then used for each samples. The flasks were firstly labeled, weighed with an analytical balance and then filled with 300 ml of petroleum ether (Hexane) in each case. Then, 2.5 g of each of the samples were weighed out with an analytical balance into a correspondingly labeled thimble. The extraction thimble was in each case tightly plugged with cotton wool. The soxhlet apparatus was then assembled and allowed to reflux for 6 hours.
When this time elapsed, the thimble was removed and the petroleum ether was collected in each case in the top of the container in the set up and drained into another container for re-use. The flasks were removed in each case and then dried in a Genlab oven at 105 ^{0}C for one hour. After drying, they were transferred into a desiccator and allowed to cool and weighed.
The percentage fat was calculated for each sample thus;

$$\text{Percentage fat} = \frac{C - A}{B} \times \frac{100}{1}$$

Where A = Weight of empty flask
B = Weight of the sample
C = Weight of oil after drying

Determination of carbohydrate content
The carbohydrate contents of each of the samples analyzed were determined by difference using the formula below;
Percentage carbohydrate = 100 – (% moisture + % ash + % crude fibre + % crude protein + % fat)

Determination of energy value of the chickpea cultivars
The energy value (calorie value) of the chickpea cultivars were calculated using the Atwater quantification method known as Atwater physiological fuel value (PFU), where the available energy for metabolism after

digestion and adsorption is termed physiological fuel value using carbohydrate, fat and protein. The PFU in Kcal were 4:9:4 for carbohydrate: fat: protein, which was termed Total Digestible Nutrient (TDN) (Onyeka et al., 1995 and Kabuo ,2008).

Carbohydrate 1g – 4Kcal
Fat 1g – 9Kcal
Protein 1g – 4Kcal

Therefore, energy value = [(Xg of carbohydrate x 4) + (Xg of fat x 9) + (Xg of protein x 4)]

Results and Discussion

Proximate composition of chickpea cultivars

The proximate composition of the chickpea cultivars are shown in Table 1.

Proximate composition of different chickpea cultivars grown under different environmental conditions, such as location, soil type, irrigation and fertilizers, may have different compositions (Chavan et al., 1989; Bishoi and Sharma, 1998, Kaur and Singh, 2005; Canadian Grain Commission, 2004)

Crude fat content of the chickpea cultivars

Legume generally contains higher fat contents than cereals (Salunkhe et al. 1985). The chickpea cultivars used in this work showed varied percentages of crude fat contents (18.28±0.03% to 35.45±0.02%). Maximum fat content was observed in sample ICCD 9586 (35.45±0.02 %) while the lowest fat content was observed in sample ICCK 9895 (18.28±0.03). The fat contents were significantly at ($p<0.05$) different from each other. In this study, Desi types showed higher fat levels than the Kabuli which had comparatively lower fat content.

Also, Desi cultivars had significantly higher fat content than the Kabuli cultivars which was not in agreement with Rincon et al., (1998). Jana and Singh (1993) have studied geographical divergence in crude fat contents and indicated that Kabuli chickpea type in Mediterranean basin is characterized by the high amount of the protein content, so naturally, they will have low fat content. So genetic selection in order to obtain higher protein content may explain the relative decreased of the fat content (Rincon et al., 1998).

Ash content of the chickpea cultivars

Table 1 shows that the ash contents of the chickpea cultivars were significantly ($p<0.05$) different among the mean value. The highest ash content was obtained in sample ICCD 867 (10.85±0.02 %), while sample ICCK 9895 had the lowest ash content (3.05±0.01 %). These results revealed that the chickpea cultivars, there were significant differences in the ash contents of the chickpea cultivars and thus can provide sufficient amount of minerals to meet the human mineral requirement.

Crude protein content of the chickpea cultivars

The highest protein content in this work was obtained from chickpea cultivar ICCK 7323 (19.46±0.02 %) while cultivar ICCD 867 had the lowest quantity of protein (12.72±0.01 %) (Table 1). Among other, chickpeas are highly valuable and economical source of vegetable protein, which include essential amino-acids (Clemente et al., 2000, Menkov, 2000).

Chickpeas are highly valuable and economical source of vegetable protein, which include essential amino-acids (Clemente et al., 2000, Menkov, 2000).The protein content of chickpea seeds is influenced by genetic and environmental factors (Chavan et al., 1986, Swanson, 1990, Owusu-Ansah and McCurdy, 1991), but in this work, the environmental factor is removed, hence, the genetic and varietal factors could have caused the significant differences among the cultivars.

The crude protein content varied from 12.72 – 19.46 %being higher in Kabuli chickpea cultivars than the Desi chickpea. The protein contents were not in line with Milan–carillo et al., (2000) findings who have reported mean protein value of 22.5% for Desi chickpea cultivar. However, the difference in value could be due to treatments given to the samples before protein analysis. Also the protein content observed in this work did not agree with the report obtained from Singh and Jambumathan (1981) who compared 8 Desi and 7 Kabuli chickpea cultivars and found higher crude protein content for Kabuli types (241 g/kg) than Desi types (217 g/kg).

In addition to genetic differences, difference in crude protein content has been reported to depend on geographical origin of seed, although the contribution of location and season in the genotypic expression of protein content is generally small.

Crude fibre content of the chickpea cultivars

Fibre constitutes a considerable proportion in human nutrition. Crude fibre in chickpeas ranges between 7.1 % and 13.5 % and include cellulose and hemicellulose, which are major crude fibre components (Chavan et al., 1986). Crude fibre is mainly concentrated in the seed coat. And studies have shown that dietary fibres are useful in reducing blood cholesterol levels (Chavan et al., 1986). The crude fibre contents the chickpea cultivars

obtained from this work ranged from 7.01 % - 11.8 % (Table 1). Cultivars ICCD 867 (Desi-type) had the highest crude fibre content (11.18±002 %), while lowest fibre content (7.01±0.02 %) was observed in sample ICCK 9895 (Kabuli-type).

Significant differences were observed in all the chickpea cultivars. The differences observed in the two types of chickpeas namely, Desi and kabuli in this study could be due to the inherited differences. The lower fibre content in Kabuli compared to Desi could be to the fact that Kabuli chickpeas have higher degradability than the Desi type. Also the thickness of the seed coat could play a role here too, as the thicker the seed coat, the higher the fibre content.

However, fibre helps in fighting cancer and reducing serum cholesterol. It also has positive effect on blood glucose and insulin concentration in both normal and diabetics, and increases faecal bulk (Nwokolo, 1996, Enwere, 1998).

Carbohydrate content of the chickpea cultivars

Legumes are good dietary carbohydrate sources (Salunkhe et al., 1985; Chavan et al., 1986). Chickpeas contain 52.4 – 70.9% total carbohydrates that constitute a major portion of the seed. The starch in chickpea is a major component of total carbohydrate (Salunkhe et al., 1985, Chavan et al., 1986). Starch is the major component of chickpeas and constitutes 37.2–50.8 % of the whole seed and 55.3 – 58.1 % of the de-hulled seed (Biliaderis et al., 1981, Chavan et al., 1986).

The carbohydrate data in this work (Table 1) shows that the highest carbohydrate content was obtained in cultivar ICCK 9895 (39.80±0.020), while the lowest was observed in cultivar ICCK 7323 (8.81±0.02). Carbohydrate contents varies significantly ($p<0.05$) between the cultivars. These cultivars of chickpea could not be used as a carbohydrate source because of the general low carbohydrate content of the samples.

Energy (calorie) value of the chickpea cultivars

Energy value of chickpea is the amount of potential energy in chickpea that can be converted into actual food energy. Statistical analysis of data is shown in Table1. Higher energy value was observed in sample ICCD 12866 (450.67±0.02 kcal/g), while the lowest value was observed in sample ICCK 7323 (345.60±0.02 kcal/g). There was significant ($p<0.05$) difference among the energy value of the cultivars.

The energy values of the cultivars were slightly higher than the energy value of most legumes which ranged from 333 kcal/g to 350 kcal/g (Latham, 1997). This suggests that chickpea could provide adequate energy required for human consumption and for food security.

Moisture content of the chickpea cultivars

Moisture level determination is an integral part of the proximate composition analysis of the foods. Data revealed that the highest level of moisture was observed in cultivar ICCK 7323 (33.19±0.02 %), whereas cultivar ICCD 12866, had the lowest moisture content (13.55±0.03 %).

Conclusion and recommendation

The principal objective of this research work is mainly to compare proximate compositions on some cultivars of chickpea harvested from the Department of Crop Science and Technology research farm Federal University of Technology, Owerri Imo State, Nigeria in order to assess their nutritional values. The difference in values among the chickpea cultivars might be attributed to seed type and maturity only, as they were planted on the same soil type. The results of the study suggested that chickpea cultivars have good nutritional qualities. The high energy, protein and carbohydrate contents suggest that chickpea could be of great importance in alleviating protein-energy malnutrition. It is recommended that more agronomic studies should be done on this legume with a view to cultivating it in Nigeria.

In view of the proximate composition data, these Desi and Kabuli chickpea cultivars can be an economic and alternative protein source that could alleviate protein malnutrition in developing countries, if the crop is given wider publicity as to the nutritional benefits.

Chickpea cultivar should therefore be used in formulation of processed food and in enrichment and/or complementation of foods; this could improve overall nutritional status of functional foods especially in developing countries.

Work should be carried out on anti-nutritional factors and functional properties of chickpea cultivars.

Acknowledgement

I sincerely wish to thank Dr S.A.Dialoke (a legume entomologist) who imported the chickpea cultivars from ICRISAT, India and successfully grown the cultivars in the Department of Crop Science and Technology, Postgraduate Teaching and Research farm, Federal University of Technology, Owerri, Imo State from where I obtained the chickpea pods used for this research work. I also thank the laboratory technologist Miss Kasarachi

Ehiogu who assisted me in the laboratory analysis of the samples and to my son Mr Chimdia P. Kabuo who typed the manuscript. I wish him well.

Table 1: Mean percentage values of proximate composition of chickpea cultivars in Imo State, Nigeria.

Sample	Moisture	Ash	Fat	Fibre	Protein	Carbohydrate	Energy value (kcal/g)
ICCD 867	16.35±0.02^{c}	10.85±0.02^{a}	26.45±0.02^{d}	11.18±0.02^{a}	12.72±0.01^{f}	22.44±0.02^{c}	378.74±0.02^{d}
ICCK 9895	14.72±0.02^{e}	3.05±0.01^{f}	18.28±0.03^{f}	7.01±0.02^{f}	17.14±0.01^{b}	39.80±0.02^{a}	392.31±0.01^{c}
ICCD 12866	13.55±0.03^{f}	3.90±0.01^{e}	32.25±0.02^{b}	10.15±0.02^{b}	14.45±0.02^{e}	25.76±0.03^{b}	450.67±0.02^{a}
ICCD 8522	29.68±0.02^{b}	3.80±0.02^{d}	26.60±0.01^{c}	8.03±0.01^{d}	16.47±0.01^{d}	13.42±0.02^{e}	359.00±0.02^{e}
ICCD 9586	14.72±0.02^{d}	7.17±0.01^{b}	35.45±0.02^{a}	9.85±0.02^{c}	16.61±0.01^{c}	16.12±0.02^{d}	450.13±0.02^{b}
ICCK 7323	33.19±0.02^{a}	5.88±0.01^{c}	25.62±0.02^{e}	7.04±0.02^{e}	19.46±0.02^{a}	8.81±0.02^{f}	345.60±0.02^{f}
LSD	0.04	0.03	0.06	0.02	0.03	0.05	0.03

Key: Values are means of Chickpea cultivars made in three replicates ±standard deviation. Means followed by different letters are significantly ($p<0.05$) different.

References

A.O.A.C. (1995). *Official Method of Analysis* 16th edn. Association of Official Analytical chemistry, Washington D.C.

Biliaderis, C.G, Grant, D.R, and Vose ,J.R. (1981). Structural characterization of legume starches. Studies on amylose, amylopectin and beta-limit dextrins. *Cereal Chemistry* 58:496-502.

Chavan, J.K, Kadam, S.S, and Salunkhe, D.K. (1986). Biotechnology and technology of chickpea (*Cicer arietinum* L.) seeds.*CRC Critical Reviews in Food Science and Nutrition* 25: 107-158.

Clemente, A.. Vioque, J., Sanchez Vioque, R., Pedroche, J., Bautista, J., and Millan, F. (2000). Factors affecting the in vitro protein digestibility of chickpea albumins. *Journal of the Science of Food and Agriculture* 80: 79-84.

Dialoke, S.A, Emosairue, S.O., Egho, E.O., and Ogoke, I.J. (2014). Insect species associated with early maturing pigeonpea in Nigeria. Indian Journal of Entomology, 76(4): 330-336

Duke, J.A. (1981). Handbook of legumes of world economic importance. Plenum Press, New York. P. 52-57.

Elegbede, J.A. 1(998). Legumes. In: *Nutritional Quality of Plant Foods.* A.U. Osagie and O. U. Ekaeds. The Post Harvest Research Unit, Department of Biochemistry, University of Benin. Benin City Nigeria, p. 53-83.

Food and Agricultural Organization of United Nation (FAO). (2008). Economic and social department from FAO Statistical Database (FAOSTAT), Rome, Italy. http://faostat.fao.org/site/613/default.aspx

Jana, S. and Singh, K.B. (1993). Evidence of geographical divergence on kabulichickpea from germ plasm evaluation data. Crop science 33:629-632.

Kabuo, N.O. (2008). The microorganisms and compounds influencing the organoleptic properties of Ugba (fermented *Pentacle thramacrophyllea* Benth seed). Ph.D.Thesis. Federal University of Technology, Owerri. Pp 30.

Latham, M. (1997). Human Nutrition in Developing World. FAO *Food and nutrition series.No.29*.UN Rome.

Menkov, N. D. (2000). Moisture sorption isotherms of chickpea seeds at several temperatures. *Journal of Food Engineering* 45: 189-194.

Milan-carillo, j., Reyes-moreno, C. and Armienta-Rodelo, E. (2000). Physicochemical and nutritional characteristic of fresh and hardened chickpeas (*Cicer arietinum*). LWT 33:117-123.

Nwokolo, E. (1996). The need to increase consumption of pulses in the developing world.In: *Legumes and Oilseeds in Nutrition.* E. Nwokolo and J. Smart ed. Chapman and Hall, London, p. 1-11.

Owusu-Ansah, Y. J and McCurdy, S.M. (1991). Pea proteins: a review of chemistry, technology of production, and utilization. *Food Reviews International* 7: 103-134.

Onwuliri, V.A. and Obu, J.A. (2002). Lipids and other constituents of *Vignaunguiculata* and *Phaseolus vulgaris* grown in Northern Nigeria. *Food Chem. 78*: 1-7.

Onyeka, E.N, Ohungwe ,T. and uwakwe, A.A. (1995). Effect of heat treatment and deffatting on proximate composition of some Nigeria Local Soap Thickeners, Food Chem. 53:173-175.

Pittaway, J.K, Robertson, I.K., Ball, M.J. (2008). "Chickpeas may influence fatty acid and fibre intake in an ad libitum diet, leading to small improvement s in serum lipid profile and glycemic control". Journal of the American Dietetic Association 108 (6): 1009-1013.

Salunkhe, D.K., Kadam, S.S and Chavan, J.K. (1985). *Postharvest Biotechnology of Food Legumes.* Florida:

CRC Press. Saskatchewan Agriculture and Food. 2002. 2001 special crop reports.
Singh, U and Jambunathan, R. (1981). Relationship between non protein and total nitrogen in Chickpea (*Cicer arientinum L.*) seed. *J. Agric. Fd. Chem. 29*: 423-424.
Smithson, J.B, Thompson, J.A, and Summerfield, R.J. (1985). Chickpea (*Cicer arietinum* L.) P.312-390 in RJ Summerfield and EH Roberts cadel. Grain legumes crops, Collins, Indian, UK.
Swanson, B.G. (1990). Pea and lentil protein extraction and functionality. *Journal of the American Oil Chemists' Society* 67: 276-280.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar