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A Comparative Study on the Effect of Sprouting and Roasting on the Nutritive Potential and Proximate Composition of Two Varieties of Cowpea [Vigna Unguiculata]

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ABSTRACT

Cowpea seed is a nutritious component in the human diet, as well as a nutritious livestock feed. The protein in cowpea seed is rich in the amino acids, lysine and tryptophan, compared to cereal grains; however, it is deficient in methionine and cystine when compared to animal proteins. Therefore, cowpea seed is valued as a nutritional supplement to cereals and an extender of animal proteins. In the present study, an attempt has been made to study the effect of home house hold technology like sprouting and roasting on the nutritive value and proximate composition of two varieties of cowpea, the white and brown variety. The study was conducted to evaluate the effect of traditional processing methods like sprouting and roasting on the nutritional valves of cowpea (Vigna unguiculata). The most effective changes in nutritional properties of cowpea were found to be in sprouted seeds. From the results of this study which can be concluded that the sprouted seeds of cowpea is a good source of carbohydrates, protein, total dietary fibre, total amino acids, and nutritionally valuable minerals.

Keywords: Cow pea, Roasting, sprouting, Nutritional value

INTRODUCTION

Cowpea (Vigna unguiculata L. Walp.), an annual legume, is also commonly referred to as southern pea, black eye pea, crowder pea, lubia, niebe, coupe or frijole. The Cowpea (Vigna unguiculata) (International Feed Number, 5-01-661) is one of several species of the widely cultivated genus Vigna. Cowpeas are one of the most important food legume crops in the semi-arid tropics covering Asia, Africa, southern Europe and Central and South America. A drought-tolerant and warm-weather crop, cowpeas are well-adapted to the drier regions of the tropics, where other food legumes do not perform well. Cowpea originated in Africa and is widely grown in Africa, Latin America, and South East Asia and in the southern United States. It is chiefly used as a grain crop, for animal fodder, or as a vegetable. The history of cowpea dates to ancient West African cereal farming, 5 to 6 thousand years ago, where it was closely associated with the cultivation of sorghum and pearl millet.

Cowpea seed is a nutritious component in the human diet, as well as a nutritious livestock feed.

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Nutrient content of mature cowpea seed (average of eight varieties)

Protein	24.8%
Fat	1.9%
Fiber	6.3%
Carbohydrate	63.6%
Thiamine	0.00074%
Riboflavin	0.00042%
Niacin	0.00281%

The protein in cowpea seed is rich in the amino acids, lysine and tryptophan, compared to cereal grains; however, it is deficient in methionine and cystine when compared to animal proteins. Therefore, cowpea seed is valued as a nutritional supplement to cereals and an extender of animal proteins. Cowpea can be used at all stages of growth as a vegetable crop. The tender green leaves are an important food source in Africa and are prepared as a pot herb, like spinach. Immature snapped pods are used in the same way as snap beans, often being mixed with other foods. Green cowpea seeds are boiled as a fresh vegetable, or may be canned or frozen. Dry mature seeds are also suitable for boiling and canning. In many areas of the world, the cowpea is the only available high quality legume hay for livestock feed. Digestibility and yield of certain cultivars have been shown to be comparable to alfalfa. Cowpea may be used green or as dry fodder. It also is used as a green manure crop, a nitrogen fixing crop, or for erosion control. Similar to other grain legumes, cowpea contains trypsin inhibitors which limit protein utilization.

Effect of Sprouting and Roasting

Sprouting is the practice of germinating seeds to be eaten either raw or cooked. They are a convenient way to have fresh vegetables for salads, or otherwise, in any season and can be germinated at home or produced industrially. Sprouts are believed to be highly nutritious and rich in enzymes which promote good health. They are a prominent ingredient of the raw food diet and common in Eastern Asian cuisine. Sprouting is also applied on a large scale to barley as a part of the malting process. A downside to consuming raw sprouts is that the process of germinating seeds can be conducive to harmful bacterial growth.

The effect of cooking, roasting and autoclaving on mineral composition has been reported for some legumes. Also, the effect of soaking, sprouting and roasting on pigeon pea (Cajanus Cajan) and Bambara groundnut (Vigna subterna) have been reported (Elegbede, (1998). And finally, the effect of autoclaving, soaking and germination have also been reported too for lima bean (Phaseolus lunatus).

The legumes refer to the edible seeds of leguminous plants belonging to leguminosae family (Elegbede, (1998). All legumes bear pods which may be round, flat or winged, long or short, thick or thin, straight or cooled, woody or flushy. The pods usually split longitudinally at one or both edges to expose and release the seeds that it contains. The number of seeds that is contained in a pod ranges from one to several dozen. Commonly consumed legume contains 17-25% protein. The potential for protein production in most important area is greater for legumes than in cereals. Legumes meet their rot needs for nitrogen without requiring fertilizers by using the nitrogen fixing bacteria – their root nodules contain a group of soil bacteria called Rhisobium which are able to symbiotically trap nitrogen from the atmosphere and convert it to amino acids and consequently to proteins through a series of biochemical reactions.

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Hence in the present study, an attempt has been made to study the effect of home house hold technology like sprouting and roasting on the nutritive value and proximate composition of two varieties of cowpea, the white and brown variety.

Review of Literature

The increase in population and price of the cereals and other grains necessitated to search intensively for a relatively cheaper source of nutrition for inclusion in both livestock and human diet. Among leguminous seeds, horse gram (macrotyloma uniflorum) appeared to be one of the potential un-conventional food stuff (ravindran and binosundar, 2009). However the use of such un-conventional food stuff would be possible only if their use is comparatively economical and found to be non toxic. These seeds, which are unpalatable in their native state rendered consumable by the people whereas, some of the people roast the seeds and others sprout them before consumption as food.

Jirapa, et.al. (2001), yogoub and Abdalla (2007) reported that processing methods such as soaking, sprouting and cooking improved the nutritional and functional properties of plan seeds.

Obioha (1999) has shown velvet bean (mucuna cochinchinensis) to be high protein source whose anti-nutrient factors can be brought to safe level by traditional processing methods such as boiling and roasting. Several studies have shown that germination improves the nutritive value of cereals and legumes (marero et.al. 1989a; marero, et.al 1989b; Hansen, et al., 1989). Germination has also been found to decrease the level of anti-nutrients present in cereals and maximizes the level of some of the utilizable nutrients. (Nkama and Ikwlle, 1989).

Nout (1993) described roasting as a method that uses dry heat for short periods of time. Traditional roasting of grains is used primarily to enhance flavor, but other benefits include reduction of anti-nutritional factors (D' Apolonia 1798; khan, et.al, 1988; gahlawat and sehgal, 1992) and extension of storage life (Huffman and martin, 1994). Flours milled from roasted legumes showed increased water retention capacity (D'Appolonia 1978; han and khan 1990) and Viscosity (Han and Khan 1990). Heat treatment of cowpeas at 110-130°C yielded fried pasters (akara) with reduced functional, sensory and textural properties (Hung et.al., 1988; Mc waters et.al., 1988).

Germination alters the functional properties of bread flours (Hwang and bushik 1973; Ranhotra et.al., 1977; Morad and rubenthaler 1983). Nnanna et.al. (1990),found that germination of cowpea improved crust color of akara but reduced other sensory qualities, such as flavor, moistness and tenderness. It is reported to be associated with improvement in the nutritive value of seeds. (Badshah et.al., 1991; Sattar, et.al., 1995; zaabria et.al., Khattak, et.al., 2007). As the seed imbibe water the enzymes are activated and the biochemical changes take place. Proteins break into amino acids. Water-soluble vitamins such as B complex and Vitamin C are created. Fats and carbohydrates are converted into simple sugars. Weight increases as the seed absorbs water and minerals. At the same time there are reports that germination is effective in reducing phytic acid, flatulence causing oligosaccharides (namely stachyose and raffinose) and polyphenols thereby increasing protein digestibility and improving sensory properties (Lintschinger, et.al, 1997; Zanabiria, et.al., 2006; Khattak,et.al., 2007). It is reported that sprouting improved the protein/ amino acid digestibility by decreasing anti nutritional factor and increasing the true/apparent protein/ amino acid digestibility (Schutze et al., 1997 Rubio et al.,2002). According to Lorenz (1980) the practice of sprouting can be used in many different foods including breakfast items, salads, soups, casseroles, pasta and baked products. It has been recently reported that germination under different type of illumination has significant effect on biosynthesis of ascorbic acid and sprout yield of soyabean and chickpea (Mao, et.al, 2005; Khattak, et.al, 2007).

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Sudha, et.al (2003) have conducted studies on the proximate composition of horse gram. Proximate analysis is used to determine the proximate principles of any substance, as contrasted with an ultimate analysis. The proximate analysis of food refers to the analysis of the total content of a food component, not taking account of the individual compounds making up that food component. The macro compounds are generally analyzed for their proximate amounts. Kadam, et.al., (2005) investigated the improvement in cooking quality of Horse gram by pre-soaking treatment with salt solution. Earlier investigations have mentioned only the food and nutritive values of horse gram (Reddy, et.al.,(2005); Rajeswari jinka, et.al.,(2009); Gopalan, et.al.,(2004); Ravindran and binosundar, (2009). None of the research work precisely and strictly analyzed the efficiency of home processing methods like sprouting and roasting on the nutritional enhancement of the Horse gram.

Several studies on Horse gram observed that the seeds are fairly rich sources of protein, crude fiber, carbohydrates, mineral matter and low in fat content. However, the knowledge of the nutritional qualities of Horse gram under different processing conditions can be responsible for the better utilization of this traditional crop in different food formulations, which is the purpose if this study.

M.E. Rivas-Vegaa analysed the nutritional value of cowpea (Vigna unguiculata L. Walp) meals, as ingredients in diets for Litopenaeus vannamei. Five experimental meals were prepared using whole raw cowpea (WRC), dehulled (DC), cooked (CC), germinated (GC) and extruded (EXC). In his experiment, the crude protein content of WRC (26.1%) increased after germination (29.5%). Carbohydrates ranged from 69.4% to 85.9%. The trypsin inhibitor activity of WRC meal was low (7.52 U/mg dry matter), and was reduced or eliminated by cooking and extrusion. He also concluded that apparent digestibility of dry matter, protein and carbohydrate of the diet containing whole raw cowpea meal (71.1%, 85.9% and 76.7%, respectively) was similar to the control diet. Cooking and extruding of cowpea significantly increased dry matter, protein and carbohydrate digestibility in the diets. Based on these results, he suggested that cowpea meals are good sources of nutrients and can be used as ingredients in diets for L. vannamei.

Sunday Y. Giami analysed and reported the proximate composition and functional properties of raw, germinated, fermented and heat-treated cowpea flour. The functional properties he investigated were protein solubility, water and fat absorption, bulk density, foam capacity and stability. He found that germination increased the crude protein, iron and total phosphorus but decreased the carbohydrate, fat and total polyphenols content. Protein solubility was pH-dependent with a minimum at pH 4·0. Maximum protein solubility (0·39 mg/ml) was recorded for germinated flour which also showed excellent fat absorption properties. The water absorption capacity of the heat-treated cowpea flour was significantly higher ($P < 0·05$) than those of raw, germinated or fermented samples. Bulk densities of the germinated and fermented flours were reduced by 70·6% and 35·3% respectively. The foam of the raw flour was more stable than those of the processed samples. Incorporation of NaCl up to 0·2 m improved the foam capacity of the raw and processed flours.

By calculating the crude protein basis, he found that raw cowpea flour showed comparatively better water and fat absorption properties than raw winged bean or soyflour and he concluded that it may find useful applications in fabricated foods such as bakery products and ground meat formulations.

Fernanda MM analysed the Maia Seeds of Brazilian Vigna unguiculata (L) Walp cultivars (EPACE 10, EPACE 11, Pitiuba, TVu 1888, IPA 206 and Olho de Ovelha) to establish their proximate composition, amino acid content and presence of antinutritional and/or toxic factors. In his study, the seed protein, carbohydrate and oil contents ranged from 195 to 261 g kg−1 dry matter, from 678 to 761 g kg−1 dry matter and from 12 to 36 g kg−1 dry matter respectively. EPACE 10, EPACE 11, Pitiuba, TVu 1888, IPA 206 and Olho de Ovelha cultivars are rich in glutamin/glutamic acid, asparagin/aspartic acid and phenylalanine + tyrosine. The essential amino acid profile compared with the FAO/WHO/UNU scoring pattern requirements for different age groups showed that these seeds have methionine + cysteine as the first limiting amino acid for 2–5-year-old children. However, only Pitiuba, IPA 206 and Olho de Ovelha are deficient in methionine + cysteine for 10–12-year-old children. The contents of threonine, valine, isoleucine, leucine and methionine + cysteine of all cultivars were lower than those of hen egg. Haemagglutinating activity measured against rabbit erythrocytes was found to be present in the six cultivars, but only after the red cells were treated with proteolytic enzymes. All cultivars displayed protease inhibitor activity which varied from about 12.0 to 30.6 g trypsin inhibited per kg flour. Urease and toxic activities were not detected in any of the studied cultivars.

B. W. ABBEY, G. O. IBEH studied the functional properties of raw and heat processed cowpea (Vigna unguiculata, Walp) flour. The functional properties, gelation, water and oil absorption, emulsification, foaming and protein solubility of raw and heat processed cowpea flour were determined. The effects of pH and NaCl concentration on some of these functional properties were also investigated. Protein solubility vs pH profile showed minimal solubility at pH 4. Water and oil absorption capacities of raw flour were 2.4 g/g and 2.9 g/g, respectively, while heat processed flour gave 3.6 g/g and 3.2 g/g, respectively. Addition of NaCl up to 0.4% improved the emulsification capacity of raw flour while a decrease was observed in the heat processed flour after 0.2%. Least gelation concentration of raw flour was found to be 16% and heat processed flour, 18%.

Four different colors of cowpeas (*Vigna unguiculata*) (black, white, red and black/white speckled) and red kidney bean (*Phaseolus vulgaris*) were used to evaluate proximate compositions, starch content, and pasting properties by S. Sasanam, T. Paseephol, A. Moongngarm. There were no significant differences of moisture, protein, ash, fat, and carbohydrate contents of all bean types. The kidney bean had significantly lower amounts of total starch and solubilized starch compared to those of other cowpeas ($p \leq 0.05$), whereas the red cowpea and red kidney bean had highest content of resistant starch (9-10%). Decortication indicated no significant effect on the proximate compositions of all samples, but it significantly decreased the resistant starch content in cowpeas and increased the solubilized starch and total starch content in all types of cowpeas.

Aim and Objectives

- To evaluate the various processing methods of sprouting and roasting on the proximate analysis parameters such as moisture content, ash content, crude lipid, crude fiber, total carbohydrates, soluble sugar, starch, total free amino acids, calorific value, anti-nutritional factors and minerals.
- To report the changes in nutritional potential of cowpea under these processing conditions.
- To compare nutritional value of the two varieties of cowpea

MATERIALS AND METHODS

First part of the seed sample was washed with tap water and air fried for two weeks (control). Second part of the seed sample was soaked in water (1:3 w/v) overnight at room temperature (37±2°C). After soaking the seeds were drained and uniformly spread on the wet cotton cloth. It was covered with another cotton cloth and kept wet by frequent spraying of water. Germination was carried out at room temperature (37±2°C). When the sprouts were 3 days old, it was removed

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from cotton cloth and air dried for two weeks. Third part of the sample was roasted in a preheated oven at 90°C, for 10 minutes the roasted sample was cooled at room temperature.

The dried seeds of each portion were powdered in a high speed blender separately with suitable precaution to avoid contamination of samples. The powders were stored in plastic containers and kept in a refrigerator at 4°C until needed for use.

Determination of Moisture Content

Calculation

Percentage (%) of loss on drying at 105°C

$$= \frac{\text{Loss in weight of the sample}}{\text{Weight of the sample taken}} \times 100$$

Determination of ASH Content

Percentage (%) of total ash

$$= \frac{\text{Weight of the ash}}{\text{Weight of the sample taken}} \times 100$$

Determination of Acid Insoluble ASH

Percentage (%) of acid insoluble ash

$$= \frac{\text{Weight of the acid insoluble residue ash}}{\text{Weight of the sample taken}} \times 100$$

Determination of Water-Soluble Extractive and Alcohol Soluble Extractive

% water – soluble extractive

$$= \frac{\text{Weight of the extract x 100 x100}}{\text{25 x Weight of the sample taken}}$$

% alcohol – soluble extractive

$$= \frac{\text{Weight of the extract x 100 x100}}{\text{25 x Weight of the sample taken}}$$

Estimation of Protein

Principle

The blue colour developed by the reduction of the phosphomolybdic – phosphotungstic components in the folin – cioalteau reagent by the amino acid tyrosine and tryptophan present in the protein pulse the colour developed by the biuret reaction of the protein with the alkaline cupric tartarate are measured in the lowry's method.

Calculation

The amount of protein was expressed as %

Estimation of Total Free Amino Acid

Principle

Ninhydrin, a powerful oxidizing agent, decarboxylates the alpha – amino acids yields an intensely coloured bluish purple product which is calorimetrically measured at 570nm.

Ninhydrin + α-aminoacid = hydrindantin + decarboxylated amino acid + CO_2 + Ammonia

Hydrindantin + ninhydrin + ammonia = purple coloured product + water

Calculation

The amount of total amino acid present was expressed as mg/100g of the sample.

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Estimation of Crude Lipid

Principle

The property of specific solubility of lipids in non-polar solvents is utilized for exaction of lipids. In biological materials, the lipids are generally bound to proteins and they are, therefore, extracted either with a mixture of ethanol and diethyl ether or a mixture of chloroform and methanol, which helps in breaking the bonds between lipids and proteins.

Calculation

The result was expressed in terms of % crude lipids in the sample.

ESTIMATION OF CRUDE FIBER

Principle

During the acid and subsequent alkali treatment, oxidative hydrolytic degradation of the native cellulose and considerable degradation of lignin occur. The residue obtained after final filtration is weighed, incinerated, cooled and weighed again. The loss in weight gives the crude fiber content.

Calculation

% crude fibre

$$= \frac{\text{Loss in weight ignition } (W_2-W_1)-(W_3-W_1)}{\text{Weight of the sample}} \times 100$$

DETERMINATION OF TOTAL CARBOHYDRATE AND TOTAL SOLUBLE SUGARS

Principle

Carbohydrates are first hydrolysed into simple sugars using dilute hydrochloric acid. In hot acidic medium glucose is dehydrated to hydroxymethyl furfural. This compound forms with Anthrone, a green coloured product with an absorption maximum at 630nm.

Calculation

$$\text{\% of total carbohydrates} = \frac{\text{g of glucose}}{\text{Volume of test sample}} \times 100$$

$$\text{\% of total soluble sugars} = \frac{\text{g of glucose}}{\text{Volume of test sample}} \times 100$$

ESTIMATION OF STARCH

Principle

The sample is treated with 80% alcohol to remove sugars and then starch is extracted with perchloric acid. In hot acidic medium starch is hydrolysed to glucose and dehydrated to hydroxymethyl furfural. This compound forms a green coloured product with Anthrone.

Calculation: % starch = %glucose x0.9

DETERMINATION OF CALORIFIC VALUE BY DIGITAL BOMB CALORIMETER

Calculation

$$\text{Water equivalent} = H \text{ x} + (CVT + CVW) / T$$

T = Final rise in temperature in °C

M = Mass of sample in grams

H = Known calorific value of benzoic acid

W = Water equivalent in calories/°C

CVT = Calorific value of thread. (2.1 cal/cm)

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CVW = Calorific Value of ignition wire (2.33 cal /cm)
CVS = Calorific value of sample

$$CVS = \frac{T \times W + (CVT + CVW)}{M.}$$

RESULT

Table 1: Effect of Domestic Processing Methods on the Proximate Composition of Two Varieties of Cowpea

CRITERION	BROWN			WHITE		
	RAW SEEDS*	SPROUTED SEEDS*	ROASTED SEEDS*	RAW SEEDS*	SPROUTED SEEDS*	ROASTED SEEDS*
Moisture (%)	5.1±0.02	6.5±0.10	4.5±0.02	3.1±0.02	6.1±0.09	4.7±0.04
Ash content (%)	4.6±0.03	3.6±0.03	1.7±0.02	4.3±0.04	3.3±0.03	1.2±0.02
Acid insoluble ash (%)	0.6±0.06	0.3±0.03	0.2±0.01	0.5±0.04	0.4±0.02	0.3±0.02
Solubility in water (%)	18.4±1.3	16.2±1.2	15.7±1.3	17.1±1.1	15.4±1.3	12.2±1.0
Solubility in alcohol (%)	3.06±0.03	4.3±0.04	3.2±0.03	2.7±0.02	4.0±0.04	3.1±0.03
Crude protein (g/100g)	69±0.50	52±0.45	49±0.40	60±0.05	51±0.04	48±0.02
Total amino acid (g/100g)	14±0.05	19.2±0.02	10.2±0.01	11.2±0.01	24±0.02	10.8±0.01
Crude lipid (%)	1.55±0.02	0.50±0.01	1.95±0.03	1.35±0.04	1±0.02	1.25±0.01
Crude fibre (%)	1.3±0.02	5.1±0.04	0.3±0.02	2.5±0.02	3.0±0.03	1.5±0.01
Calorific value ((Kcal/100g)	360±0.04	305±0.05	320±0.02	380±0.05	310±0.03	350±0.02

*mean ±standard deviation of six replicates

Table 2: Total Carbohydrates, Total Soluble Sugars and Starch

CRITERION	BROWN			WHITE		
	RAW SEEDS*	SPROUTED SEEDS*	ROASTED SEEDS*	RAW SEEDS*	SPROUTED SEEDS*	ROASTED SEEDS*
Total carbohydrates (g/100g)	59±5.6	45±3.8	47±2.7	57±5.3	50±4.5	55±5.7
Total soluble sugars (g/100g)	6±0.47	15±0.80	12.5±1.3	12±1.3	12.5±0.9	9.5±0.84
starch (g/100g)	30±3.2	45±3.75	37±3.25	31±2.7	47±3.2	41±3.5

*mean ±standard deviation of six replicates

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DISCUSSION

- Proximate composition of cowpea (Vigna Unguiculata) as affected by sprouting and roasting were studied.
- Cowpea was proceeding from the local market and the matured dry seeds were sorted.
- First portion of the seeds were soaked in water overnight at room temperature (37±20c) and sprouted for 72hrs at the same temperature. Then it was shade dried and milled into flour.
- For roasting, the second portion of the seeds were heated in a preheated oven at 900c for 10min on a glass tray, cooled and milled into flour.
- The third portion of the seeds were milled into flour and used as control.
- The nutritional values of raw and processed seeds of cowpea were investigated using standard analytical methods.
- Based on the results obtained for proximate composition, differences in nutritional composition between the raw, sprouted and roasted seeds of cowpea were observed.
- The results from the sprouted cowpea revealed with the increased percentage concentration of moisture, ash, total amino acid, crude fibre, total soluble sugar were as the level of crude protein, crude lipid, total carbohydrates, starch levels and calorific value were reduced following sprouting.
- With respect to roasting there was an increase in percentage concentration of total carbohydrates, total soluble sugars and a decrease in moisture content, crude protein, total amino acids, crude lipid, starch, content with little change in the calorific value but not as that of sprouted seeds.
- Though roasting recorded increase in concentration of the nutritional values, the changes were not as beneficial as sprouting.
- Thus sprouting as the greatest impact on increasing the nutritive valves of cowpea were as roasting produced only less effect.
- Sprouting appeared to be a promising food processing method for improving the nutrient densities of the cowpea.

CONCLUSION

The study was conducted to evaluate the effect of traditional processing methods like sprouting and roasting on the nutritional valves of cowpea (Vigna unguiculata). The most effective changes in nutritional properties of cowpea were found to be in sprouted seeds. From the results of this study which can be concluded that the sprouted seeds of cowpea is a good source of carbohydrates, protein, total dietary fibre, total amino acids, and nutritionally valuable minerals.

Since, the seeds are commonly roasted before consumption in some regions; it is advisable not to roast them as this might not be as beneficial as sprouting. It is hoped that the results of this investigation will help to increase the awareness on the use of sprouted cowpea as a source of nutrients to supplement other major sources in food system. Such increased use of cowpea could lead to a significant alleviation of the nutritional health problems to the possible extent. In future this study may be carried out in other varieties of cowpea also to determine the nutritive potential of other varieties.

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