Assessments of Lipids Contents, Carbohydrates Contents, Protein Contents and Mineral Elements Compositions of the Seeds and Seedlings of Germinating Groundnut (Arachis Hypogea. L)

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***Abstract*: Groundnut (*Arachis hypogaea)* is an annual herb whose chief and remarkable characteristic is the production of fruits underground. Groundnut seeds provide a wide range of lipids, carbohydrates, proteins and mineral elements which can supplement human diet. This study analyzed the carbohydrates contents, lipids contents, nitrogen contents, protein contents and mineral elemental compositions of germinating groundnut (Arachis hypogea L.) seeds and seedlings. Arachis hypogea L. (Groundnut seeds) were bought in a local market in Benin City. They were sown in soil inside open plastic for seedling germination and growth at the botanical garden of the University of Benin, Nigeria. The growing seedlings were monitored and harvested at 2 –day intervals after first germination for 14 days and taken for analysis at the Nigerian Institute for Oil Palm Research (NIFOR), Benin- City, Nigeria. The result showed that there was a progressive decrease in the lipids contents from the time of germination to the seedling age of 14 days. There was also decrease in the protein contents of the seedlings from the day of germination till the fourteenth day of the seedling development. The assessment also shows an increase in the carbohydrate's contents of the seedlings during germination and development. The Magnesium contents of the seeds and seedlings decreases with the age of the plant until the twelfth day, it increased in the fourteenth day .There was a trends in the increase and decrease in the calcium, potassium and sodium contents of the seed and seedling as the groundnut germinates.**

***Keywords*: Groundnut, germination, Seeds and seedlings, decrease, increase, contents.**

I INTRODUCTION

Groundnut (*Arachis hypogaea)* is an annual herb whose chief and remarkable characteristic is the production of fruits underground. The many cultivars fall naturally into two distinct botanical groups depending upon differences between them in their branching habit. The groups are regarded as distinct sub-species, the Virginia and the Spanish or Valencia. Groundnut is one of the leading agricultural crops of the world for the production of edible plant oil and protein [1].In developing and under-developed countries, there is an urgent need for additional or new plant foods to meet; large segments of the populations from these countries suffer from malnutrition [2]. Popular legumes, such as cowpea, beans and groundnuts are consumed to complement the low protein contents of grain; animal proteins such as meat, milk and eggs are expensive and relatively difficult to acquire. However, for efficient utilization and consumer acceptance of these legume seed flours, studies of their desirable functional properties are important. Previous studies on the functional properties of flours have focused mainly on popular legumes, such as soybean, cowpea, pigeon pea, and mucuna beans (Giami [3].The chemical compositions of the groundnut seeds and cake have been studied by numerous researchers, who found variation in results. This variation has been attributed to the differences in seed variety, soil, climate, storage conditions and processing methods for oil extraction in case of the cake. The major seed proteins globulins (salt soluble) of the groundnut seed contains about 18.3% nitrogen, albumins (water soluble) and glutamines (acid or alkaline soluble).These proteins are used in several food products for their functional properties, such as emulsifying and foaming capacity, or for their nutritional properties [4]. Groundnut seeds provide a wide range of mineral elements which can supplement human dietary mineral requirements. Groundnut seeds are known to be an excellent source of certain vitamins, especially vitamins E, K and the B group. The groundnut seeds are also one of the richest sources of thiamin (B1) in plants [5]. Generally the whole groundnut seed is a source of fiber, iron, magnesium, phosphorus, niacin, folate and vitamin E, as well is flavones and phytostrogen, and other antioxidant compounds[6] Groundnut seeds contain 25 – 30% protein, 45 -55% oil, with 100 iodine value, main fatty acid: oleic, linoleic and palmitic. It is used in the manufacture of margarine; contain Ca, Mg, P and as good source of vitamins E and B, Niacin, Riboflavin and thiamin. Its poor in vitamin A [7]. Groundnut contain high percentages of oil (50–55%) and protein (25– 28%) and low percentages of carbohydrates and ash[8]. It has been observed that rain fed Sodari cultivar contained higher oil content (49.6%), but low in protein content (23.8%), while irrigated cultivars, Ashford have a higher oil content (54.8%) and lowest protein content (23.4%). The irrigated groundnut cultivars are good sources of oil and oleic acid, and have higher Oleic/Linoleic ratio, while rainfed groundnut cultivar were good sources of protein [9]. Groundnut is a rich source of oil. However, due to increasing awareness among consumers about figure and health, low-oil groundnuts are now being preferred for confectionery. The fatty acid composition of groundnut oil is influenced by both environment and genotype. Groundnut oil is composed of as many as 12 fatty acids, of which about 80% is accounted for by only two fatty acids viz. oleic and linoleic acids [5].Mature groundnut kernels were reported to contain 9.5–19% carbohydrates in which starch and sucrose are the major constituents. Jiang and Duan[10] reported that mean oil contents of seeds was ranged from 50 to 57% and mean protein content of seeds was 27.45%. [7] reported that the groundnut cakes contain 40 – 50% protein, rich in lysine and tryptophan and it was poor in methionine and cystine.

This study is aimed to assess the carbohydrates contents, lipids contents, protein contents and mineral element compositions of germinating groundnut (Arachis hypogea L.) seeds and seedlings

II. MATERALS AND METHODS

Plant Materials

Arachis hypogea L. (Groundnut seeds) were bought in a local market in Benin City, Nigeria. The seeds were separated based on their colors. The red type color was used based on their viability, purity and weights when floating test was carried. They were sown in soil inside open plastic for seedling germination and growth at the botanical garden of the University of Benin, Nigeria. The growing seedlings were monitored and harvested at 2 –day intervals after first germination for 14 days and taken for analysis at the Nigerian Institute for Oil Palm Research (NIFOR), Benin- City, Nigeria.

Each germinated seedlings numbered were dried at 50^0 C for 30 minutes using Gallenkamp oven. They were crushed and pulverized using a porcelain mortar and pestle. Each sample was wrapped in a filter paper of known weights. The dry weight of each sample of each sample was calculated by finding the difference between the filter paper and the weight of the sample and the filter paper. This was followed by bulk extracts in a soxhlet apparatus using n-hexane as solvent. After extraction of the seed and seedlings, the samples were dried using the same Gallenkamp oven and to determine the various percentage of the crude lipids.

Crude protein was determined using the American Oil Chemist AOAC [11] method. Carbohydrates extraction was done using the HACK DR/200spectrometer at 490nm wavelength. The various mineral elements (Magnesium, Sodium, Calcium, Potassium,) were determined using GallenKamp digital photometer (GDFP).Statistical analysis of standard deviation (to indicate the difference between the individual readings and true values), standard error of mean (to measure how far the mean values are away from the true values)

Parameters used

IR-Instruments reading

SR-Slope reciprocal=3.65

Colour development (CD) =25Ml

Final Volume (FV) =100ml

Weight of samples (wt.) =0.1g

Note, IR= 3.65×25×100×100

0.1×1×106

III. RESULTS AND DISCUSSIONS

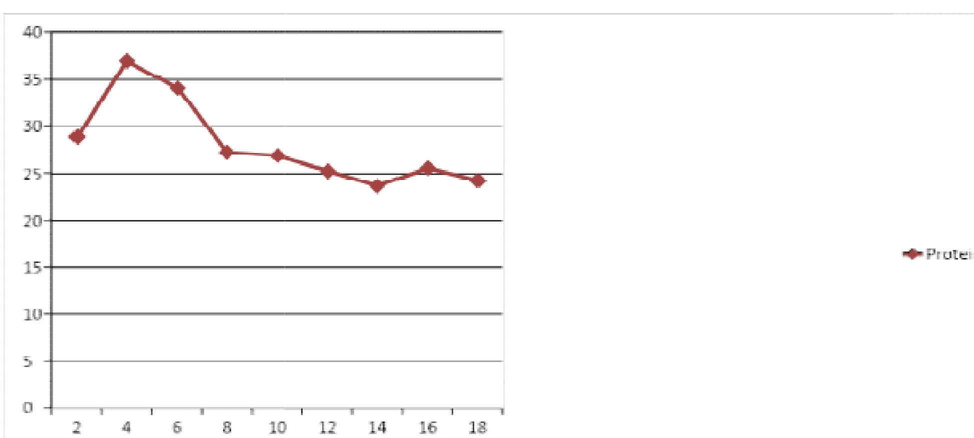

Fig.1: Time dependents changes (%) in protein contents of *Arachis hypogea* L. seeds and seedlings

Source: Laboratory analysis.

In the cotyledon, the contents of protein was 28.91%.In day 2 after germination, the protein contents increased to 36.06%,while in days 6,8,10, 12 and 14 respectively, the protein contents were 31%,26.94%,25.25%,,23.25% and 25.58% .In day 2 of the germination process, there was a sharp increase in the protein content present in the plant. As the seed germinates, the protein bodies swell and develop cavities within. This is observed in the protein content increase in day 2 and day 4. There was a decrease in day 6 and day 8 till day 14.This could be explained that, after resting bodies of the protein has been activated, growth and development occurs, later, they (tissue) breaks up into many fragments which are digested and eventually disappears within 4 – 10 days germination. The decrease in the protein contents with time may also be due to other reserve proteins- α – conarachin (major reserve protein in A. hypogea .L.) being also used up. This protein progressively decreases during germination. These reserve proteins are hydrolyzed during germination by a consortium of protease and peptidases acting co-operatively. The increase in the activity of this proteases leads to the depletion of protein contents in the plant. This is however, different from [12] who found out that the amino acid contents in peanut cotyledons and sprouts remained constant (about 30%) during germination indicating that the germination process did not markedly reduce the food protein quantity of peanut seed.

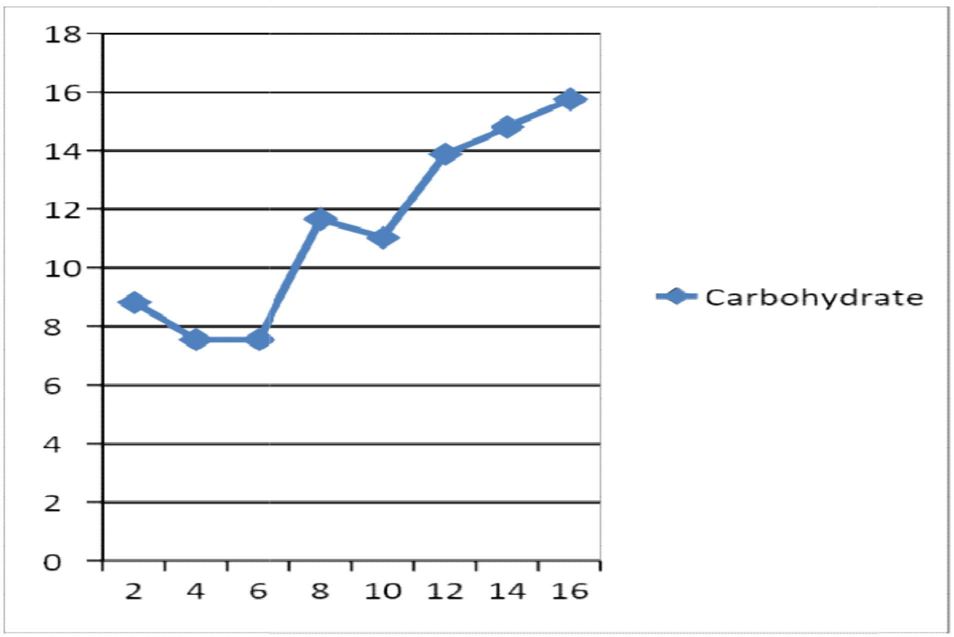

Figure 2: Time dependents changes in carbohydrate contents of *Arachis hypogea* L. seeds and seedlings

Figure 2 clearly showed the cotyledon content before imbibing water to be 8.82%, after imbibing of water by the seed, there was a progressive increase in carbohydrate contents from day 2 till day 4. In day 2, the contents of carbohydrate was 7.56% while in days 4, 6, 8, 10, 12 and 14, the carbohydrate contents were 11.66%, 11.03%, 13.87%, 14.80% and 15.75% respectively.

In this study, the Kernel (Cotyledon) was found to have a total carbohydrate content of 8.2%. This value is low compared to the above stated literature values for A. hypogea. A sharp decrease in the carbohydrate was observed in day 2 and day 4, whose figures surprisingly were equal. In day 4, there was an increase in the carbohydrate content. It continued throughout the 14-day germination period. [13] analyzed the carbohydrates contents of Five varieties of A.hypogae and found out a significantly highest amount of carbohydrate contained found in BARI Chinabadam-6 (6.275%) and was significantly highest than other varieties. The lowest amount of carbohydrate was obtained from BARI Chinabadam-8 (1.218%) which was significantly lowest among all the varieties.Agronomics practices, environmental factors as well as variation among the varieties might have influenced the carbohydrate content of the various varieties. These increases in carbohydrate contents may due to some factors such as increase in hydrolytic activities of α – amylase, β – amylase and phosphorylase. This initial increase in soluble sugars observed in the cotyledon in this study in days 4 and day 6 must have been due to accumulation prior to its transport to the embryo axis. This sharp increase in carbohydrates might be due to production and accumulation of sugar in the cotyledon and their subsequent transport to the axis and also that the conversion of some of the proteins in the cotyledon into sugars which are also transported to the embryo axis. [14] also suggested that the increase of total sugar content during seed germination was mainly due to the rise in cellulosic glucose from metabolic reaction. Increases in cellulose have also been reported in germinated legume seeds [15], [16].

TABLE I: LIPIDS CONTENTS ANALYSIS OF GERMINATING SEEDS AND SEEDLINGS OF A.HYPOGAE. L

S/n	Weights of sample before extraction	Weights of sample after extraction	Weight loss	Average % of Lipids
Days				
1	0.20	0.15	9.45	
2	0.18	0.13	8.19	8.82±0.63
3	0.15	0.10	6.30	
4	0.19	0.14	8.82	7.56±1.26
5	0.13	0.08	5.04	
6	0.21	0.16	10.08	7.56±2.52
7	0.16	0.11	6.93	
8	0.22	0.17	10.71	6.66±1.89
9	0.25	0.20	12.60	
10	0.20	0.15	9.45	5.03±1.58
11	0.26	0.21	13.23	
12	0.28	0.23	14.50	4.88±0.64
13	0.27	0.22	13.86	
14	0.30	0.25	15.75	4.80±0.95
15	0.28	0.23	14.49	
16	0.32	0.27	17.00	3.75±1.26

In this study, there was a progressive decrease in the lipid contents of the seedlings from day 2 till day 6. Thus the lipids contents for seedlings decease progressively with the age of the plant. The effect of this decrease in lipid content, as the plant matures shows the role of lipids in germination and development.

During the days of germination, these lipids are converted mostly to carbohydrate (sucrose) which is subsequently absorbed and repaired by the growing embryo. Thus, the respiratory metabolism in the endosperm of germination fatty seed is predominantly that of conversion of fats to sucrose [17].Also, energy is needed during the growth of the seedlings for cell to perform all its psychological activities. During the cause of the lipids depletion, the energy is obtained from stored food materials in the endosperm or cotyledon of a seed [17]. Another reason for lipids depletion may be due to the movement of the lipids presents in the cotyledon to the various component of the seedlings.

The plumule acquires its own lipids contents, the root and also the leaves all acquire their own lipids distributed to them through the leaves, when the seedling was reached full maturity.[12] confirmed lipids depletion during germination where fats concentration of A. hypogea decrease in fat content of peanut cotyledons and sprouts could be observed during germination, from 41.2 and 37.6 g/100 g in cotyledons and sprouts at 1 d of germination, respectively, to corresponding values of 23.4 and 10.8 g/100 g at 5 d - decreases of about two- and three-fold. Peanut is a typical oil-storing seed, and sugars and fat are the major source of energy during its germination, the significant decrease in sugar and fat contents of seeds during germination can be attributed to production of energy required for metabolic activity [18], such as synthesis of RNA, DNA, structural proteins, enzymes and other biological molecules. Similar observations were reported by [19] in soybean and [20] in field pea, chick pea, black gram and lentil. Generally, Plants like castor bean, peanut etc., store large amount of neutral lipids or fats as reserve food in their seeds. During germination, the fats are hydrolyzed into fatty acids and glycerol by lipase enzyme. Fatty acids are further converted into acetyl – CoA by the process, of oxidation. The acetyl CoA is further converted into sucrose via the glyoxylate cycle and is transported to the growing embryonic axis.

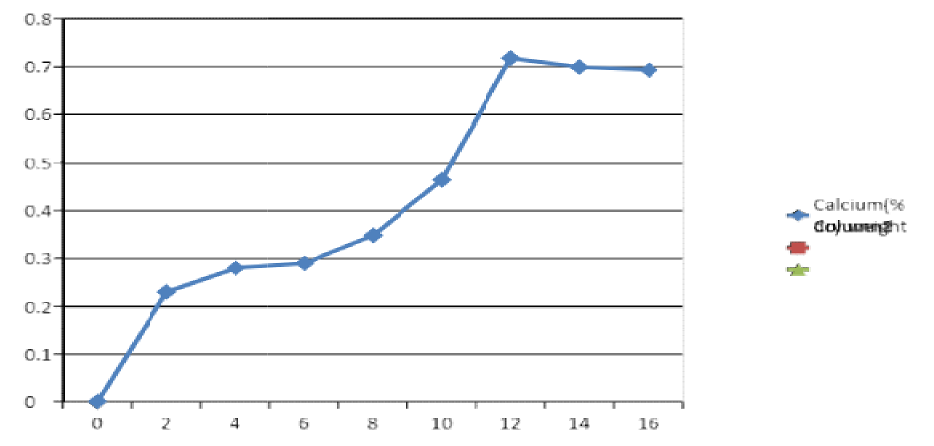

Fig.3: Time dependent changes in Calcium contents of *Arachis Hypogea* Seeds and seedlings.

Figure 3 shows the unimbibed seed (cotyledon) containing 0.23% of calcium content. After germination, the seed imbibed water which brings about a change in calcium content from day 2 till day 14. This calcium content increases progressively with the age of the plant. In day 2, the calcium content was 0.277% slightly higher than that of its kernel. It also shows that days 4, 6, 8, 10, 12 and 14 had more calcium content of 0.29%, 0.34%, 0.466%, 0.718%, 0.699% and 0.693% respectively.

In this study embryo was found to contain 0.30% calcium. This value decreased progressively in the age of the plant. In the first 2 – days, the calcium value of the seedlings was 0.23%. In the day 4, there was slight decrease in the calcium level to 0.29%. In day 4, there was a sharp increase in calcium level which continues till day 10 until there was a progressive decrease in the seedling in day 12 and day 14. This confirms the view that calcium depleted during time and that the calcium is transferred to the stem, root and leaves for good development. The analysis agreed with [12] who observed that Fe, Ca and Mg contents in germinated peanut sprouts were notably higher than that in cotyledons. At 3 d of germination, the contents of Fe, Ca and Mg in cotyledons were about 27, 70 and 66% of that in sprouts, respectively. The changes in Fe, Ca and Mg contents during germination differed for cotyledons and sprouts. Fe and Mg contents in cotyledons showed no marked changes during germination, but Ca content increased following 1d of germination. Fe and Ca contents steadily increased (4.85 -5.08 and 170.91 - 222.30 mg/100 g, respectively) and Mg content slightly decreased (349.13 -304.72 mg/100 g) in sprouts during germination. The contents of Fe, Ca and Mg in germinated peanut were noticeably higher than that in raw peanut, similar results were reported by [21]. However, [22] reported no significant variation in Fe and Ca contents of mung bean and cowpea after different germination periods. [23] found that Ca content in sesame seeds increased after germination, and Mg content fluctuated slightly, whereas Fe content decreased. [24] also reported a decreased Mg content and an increased Fe content in germinated faba bean. The differences in mineral contents among different seeds may be due to differences in species or in the germination process: cooled, boiled water was used by [21], similar to the present study; however, other studies rinsed seeds using distilled water. Various minerals are present in boiled water, but little or none in distilled water.

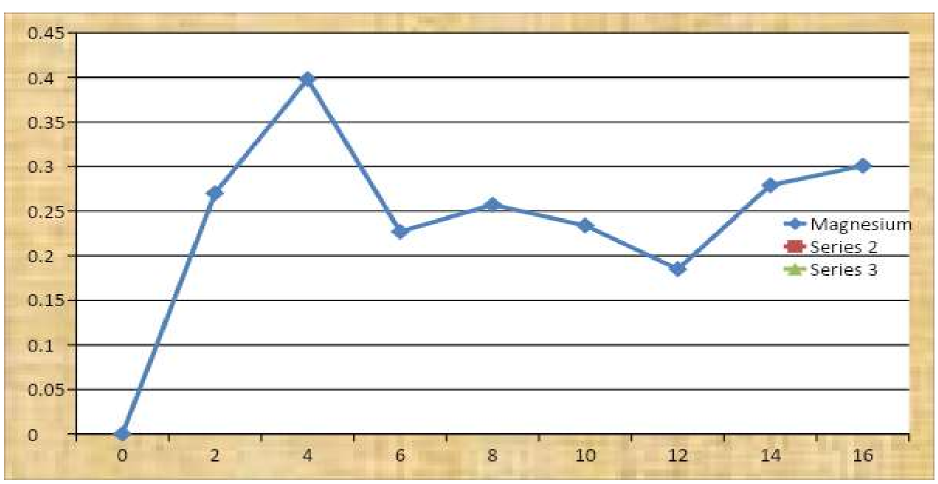

Fig. 4: Changes in Magnesium contents of *Arachis hypogea* L. seeds and seedlings.

The unimbibed seed has magnesium content of 0.27%, after germination, the contents of the seedlings changed. In day 2, the magnesium content increases sharply to 0.227% in day 4. Days 6, 8, 10, 12, and 14 had magnesium contents of 0.275%, 0.234%, 0.185%, 0.279% as shown in figure 4.This study shows that for the umimbibed seeds the potassium content was 0.77%, this figure decreases progressively with the age of the plant. This is because potassium is utilized for growth of plant. On day 4 of germination, there was a reduction in the potassium content but immediately after day 6, there was a high peak in day 8, this progressive peak in the potassium contents continues as the plant develops. The uptake and increase in the potassium may be explained because generally, potassium uptake is most active during the first two weeks or so for growth.

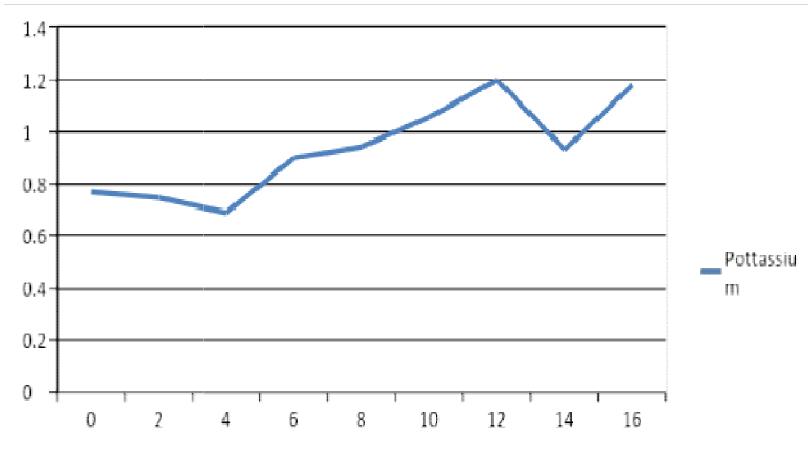

Figure 5: Change in Potassium contents of *Arachis hypogea* seeds and seedlings.

This study shows a mean value of 0.77% for the seed of the A. hypogea and this is comparable with the figure. This study shows that for the unimbibed seeds, the potassium content was 0.77%. This figure decreases progressively with the age of the plant. This is because potassium is utilized for growth of plants. On day 4 of germination, there was a reduction in the potassium content but immediately after day 6, there was a high peak in day 8, this progressive peak in the potassium contents continues as the plant develops.The uptake and increase in the potassium may be explained because generally, potassium uptake is most active during the first 2 weeks or so for growth [24].

IV. CONCLUSION

This study generally revealed that there are factors (endogenous and exogenous) that affects the growth of the seeds and seedlings of *Arachis hypogea* which causes depletions in lipids, carbohydrates, protein and mineral elements compositions as the plants germinates**.**

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