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INFLUENCE OF SPROUTING DURATIONS ON THE NUTRITIONAL COMPOSITION OF SEEDS OF TWO SESAME (*Sesamum indicum;* L.) VARIETIES

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ABSTRACT

Sesame is an important oilseed crop that provides invaluable nutrients in food products. Due to the fact that it is neglected, little is known on how sprouting days affect its nutritional quality. This study aimed to determine the effect of sprouting durations on the nutritional composition of two sesame varieties grown in Ghana. The experimental design was a 2x5 factorial design in Completely Randomized Design with three replications. Factor one was sesame varieties at two levels (Grey and Brown) and factor two was sprouting durations at five levels (0, 2, 4, 6, 8 day). The study revealed that highest carbohydrate (30.64%), protein (35.77%) and moisture (87.79%) contents were produced by the grey variety which was sprouted for 8 durations. Moreover, the best crude fibre (25.88%) content was produced by the brown variety which was not sprouted, whiles highest fat content was produced by the grey variety which was sprouted for 2 durations. Highest calcium (2.37mg/kg), phosphorus (1.49mg/kg) and potassium (1.39mg/kg) content was produced by the grey variety which was sprouted for 8 durations whiles highest magnesium content (0.79mg/kg) was produced by the brown variety which was sprouted for 2 durations. Sprouting durations and the varieties did not significantly influence sodium content of sprouted seeds. Highest nutrients from sesame seeds can be obtained by sprouting the grey variety for 8 days.

Keywords: Germination, metabolism, enzymes, nutrients, antioxidants and malnutrition.

INTRODUCTION

Sesame (*Sesamum indicum* L.) also known as “Queen of Oilseeds” is an annual crop that belongs to the family *Pedaliaceae* and is probably the most ancient oil seed known and used by mankind with both nutritional and medicinal values (Girmay, 2018, Pusadkar *et al*., 2015, Gharby *et al*., 2017). The crop is used extensively for paste, cake, confectionary purposes and flour due to its highly stable oil contents, nutritious protein (rich in methionine, tryptophan and valine) and savoury nutty roasted flavour (Zebib *et al.* 2015). The seeds are used either decorticated or whole in sweets such as sesame bars and halva, in baked products, or milled to get high-grade edible oil or tahini, an oily paste (Bedigian, 2004).
The Sesame oil which has been traditionally used for cooking and as a flavour additive in food products of Asian and Western countries (Pastorello *et al*., 2001). Antioxidant and anticancer properties have been studied in Sesame seeds (Osawa *et al*., 1990). Sesamin and sesamolin, two unique phytoconstituents isolated from seeds, possess excellent cholesterol-lowering effect in humans and prevents high blood pressure. They serve as a good source of copper, manganese and calcium which are effective in reducing pain, in osteoporosis and in reduction of swelling in rheumatoid arthritis (Chakraborthy *et al*., 2008)
In spite of the many advantages of the crop, it has been mentioned as an ‘orphan crop’ and no considerable attention has been given to the study of sesame crop in Ghana. Consequently, there are scanty research reports on the chemical and nutritional attributes of sesame seeds produced in Ghana. Processing methods, such as; soaking, sprouting and cooking have been reported to improve the nutritional and functional properties of certain plant seeds (Jirapa *et al.,* 2001).
Consumption of seed sprouts, which has been known for many centuries in oriental culture, has been growing in global popularity over the past 30 years (Robertson *et al.,* 2002). Bean sprouts, rich in dietary fibres, various nutrients, and bioactive components, are important vegetables consumed in Asian countries, and, nowadays they have become more popular in the United States and European countries (Liu *et al.,* 2008). Although the most popular bean sprouts are cultivated from mung bean and soybean, sesame seeds are also a good source of nutrients from its sprouts (Liu *et al.,* 2011). For instance, Sesame sprouts have been consumed as vegetables in China for hundreds of years (Liu *et al.,* 2011). Sprouting has been used as a technique to minimize disadvantages of undesirable flavour and odour in other products (Agrahar-Murugkar *et al.,* 2013). Sprouting triggers a sequence of metabolic changes resulting in improvement of nutritional quality of legumes and reduction of the anti-nutritional factors such as trypsin inhibitor and phytic acid (Agrahar-Murugkar *et al*., 2013).
Very little scientific information is known about how different sprouting durations affect the nutritional composition of sesame seeds. To this end, the main objective of this study was to determine the effect of sprouting durations on the nutritional composition of two sesame varieties.

MATERIALS AND METHODS

Study site

The study was conducted at the Department of Horticulture, of KNUST. Laboratory analyses were conducted at the Department of Crops and Soil Sciences.

Source of seeds for the study

Seeds (Grey and Brown) varieties were obtained from a sesame seed farm in *Mognore,* a suburb of Bawku Municipal in the Upper East Region of Ghana. Seeds were transported to KNUST in ziplock bag containers for the experimental set up.

Experimental design and procedure

A 2x5 factorial design in Completely Randomized Design with three replications was used for the study. Factor one was sesame varieties at two levels (Grey and Brown) and factor two, sprouting durations at five levels (0, 2,4,6,8 durations). The seeds were washed with distilled water to get rid of debris and soaked in 2 bowls of water (one bowl for Brown Sesame and the other bowl for Grey Sesame) for about 6 hours. The water was then drained out with the aid of a sieve. 10kg of the seeds were used for this experiment. That is, 5kg of Grey Sesame seeds and 5kg of Brown Sesame seeds. 1kg each, of grey and brown Sesame seeds were stored in a dry container to prevent germination, which served as control. 3 grams of the soaked seeds was measured into each sprouting Jar weighing 375.82g, 17cm height and 7cm top diameter and the top opening of the jar was covered with gauze and fastened with a truncated lid of the jar. The fastened jars were then placed upside down in a chamber at an angle of about 45 degrees to ensure complete draining out of water, and monitored on daily bases for its sprouts. 1.5 litres of distilled water was used to rinse the seeds in each jar through the gauze without opening the lid. That is, 1.5 litres each for each jar in the morning and each for each jar evening. Sprouts were collected after every 2 durations and were oven dried at 60°C for 72 hours until the moisture content is reduced to about 5%. The dried seeds were milled into powder for proximate and minerals analysis.

Plate 1: Sesame seeds which were not sprouted

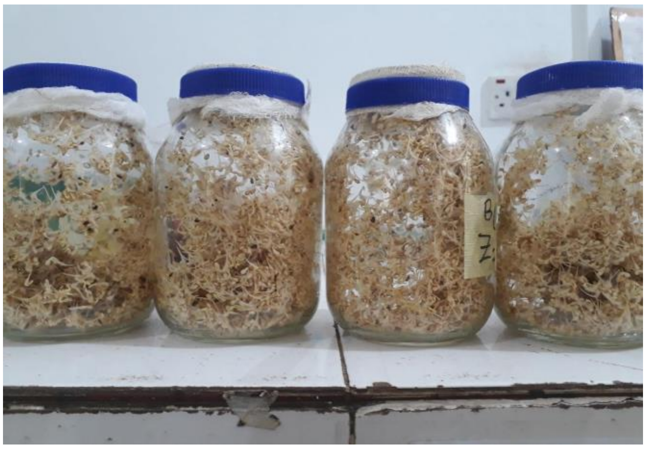

Plate 2: Sesame seeds which were sprouted for 2 durations.

Plate 3: Sesame seeds which were sprouted for 4 durations.

Plate 4: Sesame seeds which were sprouted for 6 durations.

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Plate 3.5: Sesame seeds which were sprouted for 8 durations.

DATA COLLECTED

Determination of Moisture Content

Two grams each of the sample was weighed into an already weighed moisture can. At an oven temperature of 60°C for 24 hours the samples were then dried. After drying they were put into the desiccator and allowed to cool after which it was reweighed. Drying continued until a constant weight was obtained. The moisture was calculated as the difference in weight of the original sample in percentage.

Calculations i

(A + B) – A = B (A + B) – (A + C) = B - C = D

% Moisture = D/B x 100. Where A = crucible wt., B = sample wt., C = dry sample wt.,
D = moisture wt.

Determination of Crude Protein

The micro Kjeldahl method was used for determining the Protein content (A.O.A.C., 1990). Two grams of the weighed into a heating tube after which it was mixed with 10ml concentrated H_2SO_4. The mixture was heated inside a fume cupboard after the addition of one table spoon selenium catalyst after which it was transferred into a distilled water. Equal portion of 10ml 45% NaOH was added after which it was transferred into a Kjeldahl distillation apparatus. Distillation of ithe mixture was carried out and the distillate as received into a 4% boric acid solution containing 3 drops of methyl red indicator. A 50ml sample of the distillate was collected and titrated as well. The sample was triplicated and mean calculated. A calculation of the nitrogen content was made after which it was multiplied by a factor of 6.25 to obtain the crude protein content. This was given as:

Percentage Nitrogen = 50(S-B) × 0.019057 × 0.0140× 100 10 × wt. of sample

%P = % N × 6.25
Where S = Titre value
B = Blank (0.20)
% P = Percentage Protein

Determination of Ash Content

Two grams (2g) each of the samples was weighed into a porcelain crucible of known weight after which it was placed into the muffle furnace for ashing at 550°C within 3hours. Ashing was carefully done until samples turned white and were free of carbon. The sample was cooled in a desiccator after ashing to a room temperature and reweighed. The weight of the residual ash was then calculated as:

Calculations

(A + B) – A = B
(A + C) - A = C
% Ash =C/B x 100 where A = crucible weight, B = sample weight, C = ash weight.

Determination of Crude Fibre

Two grams (2g) of the sample was boiled with a 200ml H_2SO_4 (1.25%) in the presence of 1g asbestos for 30 iminutes. The acid mixture was filterediusing a muslin cloth placed over a Buchner funnel. The residue was thoroughly washed with boiling water until it was free from acid. The process was repeated using 200ml of 1.25% NaOH after which it was washed with 10ml of 95% ethanol. The residue obtained was scooped into a clean dried porcelain crucible. It was dried in the oven at 100°C to a constant weight.

The dried sample was cooled and reweighed. The difference in weight calculated was used for calculating the percentage crude fibre content from the formula shown below.

Calculation

% crude fibre = $\frac{A - B}{C}$ x100 where A =wt. of dry crucible and sample

B = wt. of incinerated crucible and ash, C = sample weight.

Determination of Crude Fat

Two grams of each sample was loosely wrapped with a filter paper nto thimble containing 120ml petroleum ether after which it was fitted with an already weighed round bottom flask. It was iconnected to a condenser and a soxhlet extractor over a heating mantle. Reflux was allowed for 3hours undisturbed. After the set period, the flask containing the ether and the extracted fat were heated until all ether present evolved. The flask was dried in ithe oven at 100°C for 10 minutes. The flask was reweighed and the percentage fat content calculated.

Calculation i

% Fat = $\frac{A - B}{C}$ x100 where A = wt. of flask and extracted fat, B =weight of fat C= sample weight.

Determination of Carbohydrate

The carbohydrate was calculated as the nitrogen free extract described by Association of Official Analytical Chemists (A.O.A.C 1990) by summing up all the proximate parameters and deducting from 100.

Calculation

Nitrogen free Extract (NFE)= 100-(m + p + f1 + A +f2)
Where=ash f2 = Crudei fibre, m =

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moist
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f1=
Fat

Determination of Potassium, Calcium, Phosphorus and Magnesium content of sesame seeds samples

Potassium (K), Calcium (Ca), Phosphorus (P) and Magnessium (Mg) content were determined using methods based on Association of Official Analytical Chemists (AOAC, 1990 Methods C 973.3; 969.32; 984.27; and 990.05). A 1.0g of sample was weighed into a porcelain crucible and ashed for 4 hours at 500°C. Ten milliliters (10 ml) of 1:5 HCl to water was added to the ashed sample, digested on a hot plate and boiled for 2 imins. The digest was then filtered into a 100 ml flask. The filtrate was made to the 100 ml meniscus mark of the volumetric flask using distilled water. The solution was further diluted with distilled water at a ratio of 1:50 using a combined solution of 2.5 ml lanthanum solution and 2.5 ml cesium oxide to remove the interference of other cations. Potassium, Zinc, Calcium and Iron levels were read using AAS by preparing standards for each element at their specific elemental wavelength after calibration.

DATA ANALYSIS

Data obtained from the laboratory analysis was subjected to Analysis of Variance (ANOVA) using STATISTIX version 10. The differences in means were separated using Tukey's Honesty significant difference (HSD) at 1%. The results were then presented in tables and figures.

RESULTS

Carbohydrate content of sprouts of two sesame varieties as influenced by sprouting durations

The interaction between the two sesame varieties and sprouting durations for carbohydrate content of sprouted seeds showed statistically significant differences (p≤0.01) as shown in Figure 1. Significantly highest carbohydrate content (30.64%) was produced by the grey variety which was sprouted for 8 days and the least (10.46%) was the brown variety which was not sprouted. Considering the sprouting durations only, seeds sprouted for 8 days had the highest carbohydrate content (25.74%) and the least was the unsprouted ones (14.58%). For the varieties only, grey variety had the highest carbohydrate and the least was the brown.

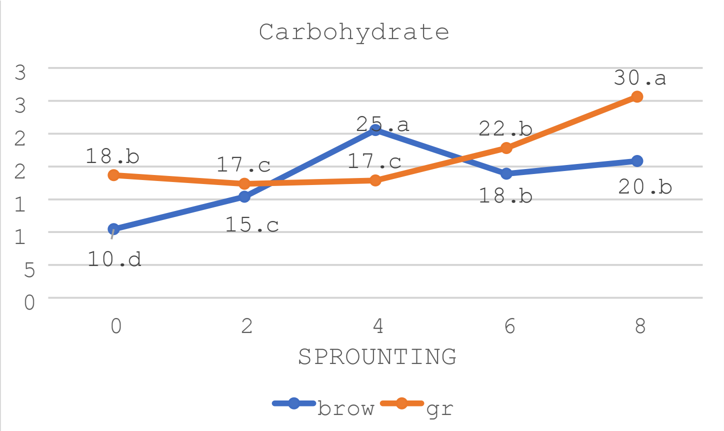

Figure 1: Carbohydrate content (%) of sprouts of two sesame varieties as influenced by sprouting durations

Crude fibre content of sprouts of two sesame varieties as influenced by sprouting durations

The interaction between the two sesame varieties and sprouting durations for crude fibre content of sprouted seeds showed statistically significant differences (p≤0.01) as shown in Figure 2. Significantly highest crude fibre content (25.88%) was produced by the brown variety which was not sprouted and the least were both brown and grey varieties which were sprouted for 4 days. Considering the sprouting durations only, seeds which were not had the highest crude fibre content (23.99%) and the least was those sprouted for 4 days (15.53%). For the varieties only, brown variety had the highest fiber (20.89%) and the least was the grey (17.45%).

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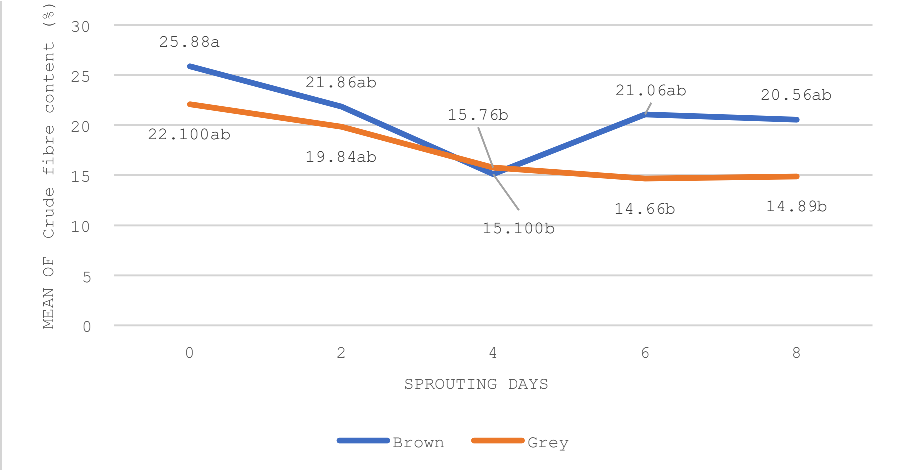

Figure 4.2: Crude fibre content (%) of sprouts of two sesame varieties as influenced by sprouting durations

Fat content of sprouts of two sesame varieties as influenced by sprouting durations

The interaction between the two sesame varieties and sprouting durations for fat content of sprouted seeds showed statistically significant differences (p≤0.01) as shown in Figure 3. Significantly highest fat content (35.43%) was produced by the grey variety which was sprouted for 2 days but it was similar to the brown variety which was not sprouted and the least (14.33%) was the grey variety which was sprouted for 8 days. Considering the sprouting durations only, seeds sprouted for
2 durations had the highest fat content (34.88%) and the least was those sprouted for 8 days (16.58%). For the varieties only, there were no differences between the brown and the grey.

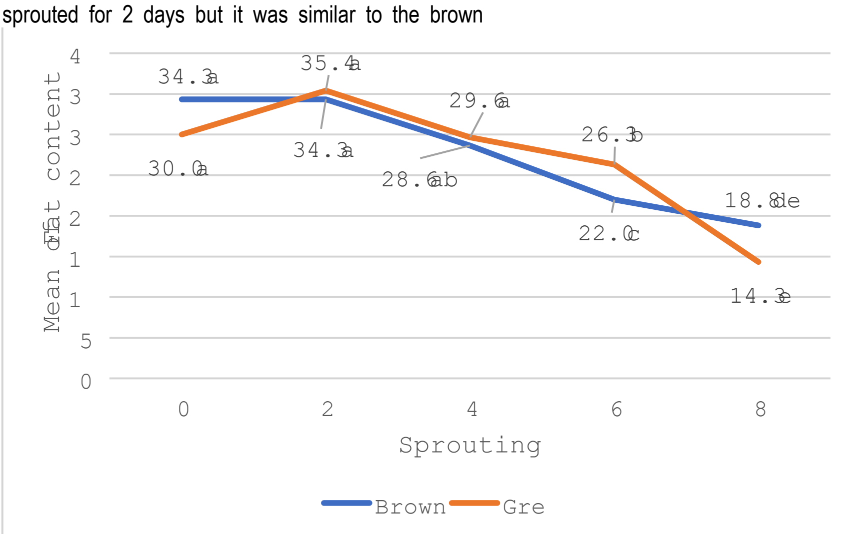

Figure 3: Fat content (%) of sprouts of two sesame varieties as influenced by sprouting durations

Moisture content of sprouts of two sesame varieties as influenced by sprouting durations

The interaction between the two sesame varieties and sprouting durations for moistture content of sprouted seeds showed statistically significant differences (p≤0.01) as shown in Figure 4. Significantly highest moisture content was produced by both the grey and brown varieties which were sprouted for 6 and 8 days and the least (14.33%) was the grey and brown varieties which were not sprouted. Considering the sprouting durations only, seeds sprouted for 6 and 8 days had the highest moisture contents and the least was those which were not sprouted. For the varieties only, there were no differences between the brown and the grey.

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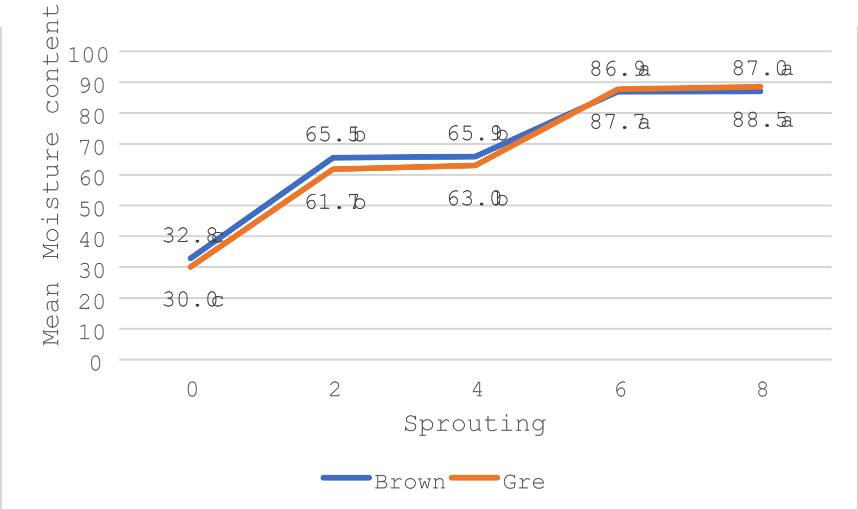

Figure 4: Moisture content (%) of sprouts of two sesame varieties as influenced by sprouting durations

Protein content of sprouts of two sesame varieties as influenced by sprouting durations

The interaction between the two sesame varieties and sprouting durations for protein content of sprouted seeds showed statistically significant differences (p≤0.01) as shown in Figure 5. Significantly highest protein content (35.77%) was produced by the brown variety which was sprouted for 8 days and the least was both grey and brown varieties which was not sprouted as well as those sprouted for 2 days. Considering the sprouting durations only, seeds sprouted for 8 durations had the highest protein content (34.78%) and the least was those sprouted for 0 and 2 durations.

For the varieties only, there were no differences between the brown and the grey.

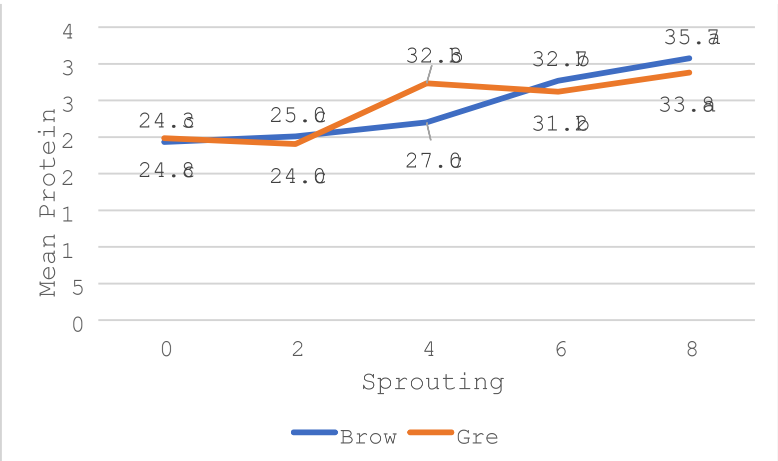

Figure 5: Protein content (%) of sprouts of two sesame varieties as influenced by sprouting durations

Ash content of sprouts of two sesame varieties as influenced by sprouting durations

The interaction between the two sesame varieties and sprouting durations for ash content of sprouted seeds showed no statistically significant differences (p≤0.01) as shown in Figure 6.

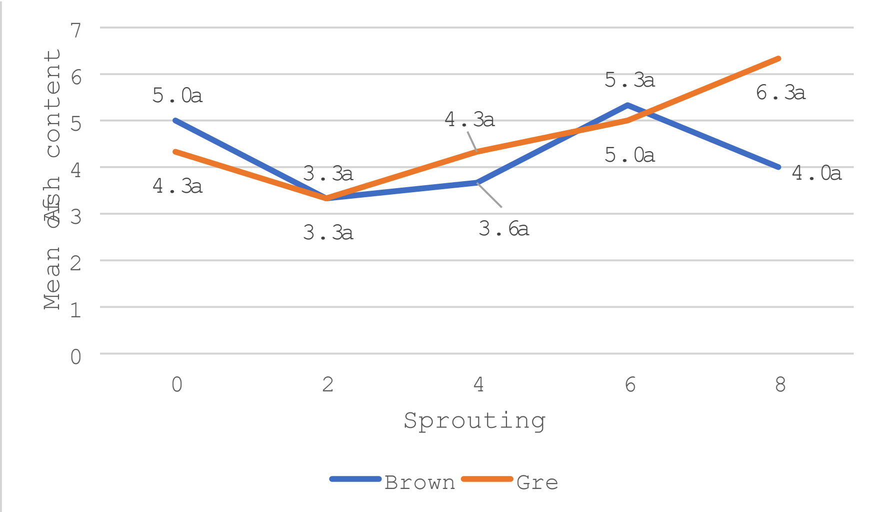

Figure 6: Ash content (%) of sprouts of two sesame varieties as influenced by sprouting durations

Calcium content of sprouts of two sesame varieties as influenced by sprouting durations

The interaction between the two sesame varieties and sprouting durations for calcium content of sprouted seeds showed statistically significant differences (p≤0.01) as shown in Table 1. Significantly highest calcium content (2.37mg/kg) was produced by the grey variety which was sprouted for 8 days and the least (0.69) was grey variety sprouted for 2 days. Considering the sprouting durations only, seeds sprouted for 8 days had the highest calcium content (2.29 mg/kg) and the least was those sprouted for 2 days. For the varieties only, highest calcium (1.60 mg/kg) was obtained in the grey variety and the least was the brown (1.47 mg/kg)

Table 1: Calcium content (mg/kg) of sprouts of two sesame varieties as influenced by sprouting durations

	Variety		
Sprouting Durations	Brown	Grey	Means
0	2.04^{d}	2.12^{c}	2.08^{b}
2	0.61^{j}	0.77^{i}	0.69^{e}
4	0.93^{h}	1.01^{g}	0.97^{d}
6	1.59^{f}	1.71^{e}	1.65^{c}
8	2.21^{b}	2.37^{a}	2.29^{a}
Means	1.47^{b}	1.60^{a}	

CV =1.12
HSD (0.01): Variety=0.02, Sprouting Durations=0.04 Interaction=0.06

Footnote: CV: coefficient of variation; HSD: honest significant difference; Sprouting durations:0,2,4,6,8 are number of days; Means followed by the same letter(s) within a treatment group are not significantly different at 1% level of probability.

Potassium content of sprouts of two sesame varieties as influenced by sprouting durations

The interaction between the two sesame varieties and sprouting durations for potassium content of sprouted seeds showed statistically significant differences (p≤0.01) as shown in Table 2. Significantly highest potassium content (1.49 mg/kg) was produced by the grey variety which was sprouted for 8 days and the least (0.69 mg/kg) was brown variety which were not sprouted. Considering the sprouting durations only, seeds sprouted for 8 days had the highest potassium content (1.39 mg/kg) and the least was those not sprouted 0.93). For the varieties only, highest potassium (1.18 mg/kg) was obtained in the grey variety and the least was the brown variety (1.11 mg/kg).

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Table 2: Potassium content (mg/kg) of sprouts of two sesame varieties as influenced by sprouting durations

	Variety		
Sprouting Durations	Brown	Grey	Means
0	0.93^{f}	0.93^{ef}	0.93^{e}
2	1.15^{d}	0.93^{ef}	1.04^{d}
4	0.94^{e}	1.27^{c}	1.10^{c}
6	1.27^{bc}	1.28^{bc}	1.27^{b}
8	1.28^{b}	1.49^{a}	1.39^{a}
Means	1.11^{b}	1.18^{a}	

CV =0.32
HSD (0.01): Variety=3.76, Sprouting Durations=7.84 Interaction=0.13

Footnote: CV: coefficient of variation; HSD: honest significant difference; Sprouting durations:0,2,4,6,8 are number of days; Means followed by the same letter(s) within a treatment group are not significantly different at 1% level of probability.

Magnesium content of sprouts of two sesame varieties as influenced by sprouting durations

The interaction between the two sesame varieties and sprouting durations for magnesium content of sprouted seeds showed statistically significant differences ($p \leq 0.01$) as shown in Table 3. Significantly highest magnesium content (0.79) was produced by the brown variety which was sprouted for 2 days and the least (0.07) was brown variety which were sprouted for 8 days. Considering the sprouting durations only, seeds sprouted for 2 days had the highest potassium content (0.71) and the least was those sprouted for 8 days (0.11). For the varieties only, highest magnesium (0.44) was obtained in the brown variety and the least was the grey variety (0.35)

Table 3: Magnesium content (mg/kg) of sprouts of two sesame varieties as influenced by sprouting durations

	Variety		
Sprouting Durations	Brown	Grey	Means
0	0.33^{cd}	0.31^{de}	0.32^{c}
2	0.79^{a}	0.62^{b}	0.71^{a}
4	0.65^{b}	0.33^{c}	0.52^{b}
6	0.27^{e}	0.31^{de}	0.29^{d}
8	0.14^{f}	0.07^{g}	0.11^{e}
Means	0.44^{a}	0.35^{b}	

CV =3.44
HSD (0.01): Variety=0.04, Sprouting Durations=0.03 Interaction=0.05

Footnote: CV: coefficient of variation; HSD: honest significant difference; Sprouting durations:0,2,4,6,8 are number of days; Means followed by the same letter(s) within a treatment group are not significantly different at 1% level of probability.

Sodiun content of sprouts of two sesame varieties as influenced by sprouting durations

The interaction between the two sesame varieties and sprouting durations for sodium content of sprouted seeds showed no statistically significant differences ($p \leq 0.01$) as shown in Table 4.

Table 4: Sodium content (mg/kg) of sprouts of two sesame varieties as influenced by sprouting durations

	Variety		
Sprouting Durations	Brown	Grey	Means
0	0.04^{a}	0.04^{a}	0.04^{a}
2	0.04^{a}	0.04^{a}	0.04^{a}
4	0.04^{a}	0.04^{a}	0.04^{a}
6	0.06^{a}	0.06^{a}	0.06^{a}
8	0.06^{a}	0.06^{a}	0.06^{a}
Means	0.05^{a}	0.05^{a}	

CV = 0.40
HSD (0.01): Variety=0.01, Sprouting Durations=0.02 Interaction=0.04

Footnote: CV: coefficient of variation; HSD: honest significant difference; Sprouting durations:0,2,4,6,8 are number of days; Means followed by the same letter(s) within a treatment group are not significantly different at 1% level of probability.

Phosphorus content of sprouts of two sesame varieties as influenced by sprouting durations

The interaction between the two sesame varieties and sprouting durations for phosphorus content of sprouted seeds showed statistically significant differences ($p \leq 0.01$) as shown in Table 5. Significantly highest phosphorus content (0.85 mg/kg) was produced by the grey variety which was sprouted for 8 days and the least (0.51 mg/kg) was the same grey variety which were not sprouted. Considering the sprouting durations only, seeds sprouted for 8 days had the highest potassium content (0.83 mg/kg) and the least was those which were not sprouted (0.53 mg/kg). For the varieties only, highest phosphorus (0.68 mg/kg) was obtained in the grey variety and the least was the brown variety (0.62 mg/kg).

Table 5: Phosphorus content (mg/kg) of sprouts of two sesame varieties as affected by different sprouting durations

	Variety		
Sprouting Durations	Brown	Grey	Means
0	0.54^{g}	0.51^{h}	0.53^{e}
2	0.55g	0.61^{e}	0.58^{d}
4	0.58^{f}	0.64^{d}	0.61^{c}
6	0.63^{de}	0.77^{c}	0.70^{b}
8	0.80^{b}	0.85^{a}	0.83^{a}
Means	0.62^{b}	0.68^{a}	

CV = 0.85
HSD (0.01): Variety=0.0005, Sprouting Durations=0.01 Interaction=0.02

Footnote: CV: coefficient of variation; HSD: honest significant difference; Sprouting durations:0,2,4,6,8 are number of days; Means followed by the same letter(s) within a treatment group are not significantly different at 1% level of probability.

DISCUSSION

Results obtained in this study showed that highest carbohydrate content was produced by the grey variety which was sprouted for 8 days and the least was the brown variety which was not sprouted. This could be due to the different genetic composition of the varieties selected for the study. The composition of the sesame seed is dependent on genetic, environmental factors, genotype, cultivation, climate, ripening stage, the harvesting time of the seeds and the analytical method used (Yasothai, 2014; Rababah *et al*., 2017; Ahmed *et al*., 2018). Longer sprouting durations increased the carbohydrate content probably because sprouting increased the activation of enzyme functions and converting carbohydrates to digestible sugars and thereby increasing the nutritional value of vitamins and minerals, and bringing full digestibility to carbohydrates. It is also possible that the breakdown of carbohydrate reserves during germination led to its accumulation in the later periods of sprouting. The results obtained in this study corroborates with the findings of Nkhata (2018) who reported of similar increase in carbohydrates for cereals.

Dietary fibre was regarded as one of the most important ingredients in human diet (Dhingra *et al*., 2012). The characteristics of dietary fibre such as particle size, bulk volume, surface area characteristics, hydration, and adsorption as well as binding of ions and organic molecules are highly influential in human digestive system (Guillon *et al*., 1998; Nassar *et al*., 2008; Dhingra *et al*., 2012). It was observed that addition of dietary fibre components in foods such as pasta, bakeries and biscuits improved the overall qualities such as biochemical composition, cooking properties and textural characteristics as well as the itaste (Tudoric *et al*., 2002; Nassar *et al*., 2008). Apart from that, dietary fibre can also be used to improve texture of meat products (Chevance *et al*., 2000) as well as functional ingredients in milk products (Sendra *et al*., 2008).

Our results showed that highest crude fibre content was produced by the brown variety which was not sprouted. This suggests that, seeds which were not sprouted maintained highest crude fibre as compared to the sprouted ones. This could be attributed to the depletion of fibre reserves at the early stages of sprouting thereby reducing the fibre content with increasing sprouting durations. The unsprouted seeds however, did not affect the fibre content. Studies show that when seeds are sprouted, the amount of fiber they contain increases and becomes more available as reported by Megat *et al*. (2016).

Results indicated differences in genotype for the fat content. The longer the sprouting durations, the lower the fat content. This observation could be due to depletion of stored fat that was brought about by the catabolic activities of the seeds in the seed during sprouting (Onimawo and Asugo 2004). Ali and Elozeiri (2017) reported that the energy required for protein synthesis in plant growth was facilitated by nutrient reserve (lipids and carbohydrates) degradation in process of sprouting. Energy generated through the oxidation of fatty acids to CO_2 and H_2O leads to the synthesis of certain structural constituents in young seedlings (Kwon, 1994). After 4 days of sprouting sesame seeds, there was 44 % decrease in fat content (Hahm *et al*. 2009). Our results corroborate with the findings of Uppal and Bains (2012) who opined that the fat content of three cowpea genotypes which were sprouted significantly decreased when compared to the unsprouted ones.

The highest moisture content revealed in the result was produced by both the grey and brown varieties, which were sprouted for 6 and 8 durations and the least was the grey and brown varieties which were not sprouted. Sprouting is highly associated with seed hyrdation which elevates the moisture content of the sprouts. High amount of water imbibition at the initial phase of seed germination may be the cause of the increase in moisture content of the sprouts (Nonogaki *et al*., 2010)

In the present study, highest protein content (35.77%) was produced by the brown variety which was sprouted for 8 days. Apparent increase in protein content may be attributed to loss in dry matter, particularly carbohydrates through respiration during sprouting (Uppal and Bains 2012). Higher sprouting temperature and longer sprouting time would mean greater loss in dry weight and more increase in crude protein content. There is reawakening of protein synthesis upon imbibition (Nonogaki *et al*. 2010), which leads to increase in protein content in sprouted seeds. In terms of the sprouting durations, seeds sprouted for 8 durations had the highest protein content. Mehta *et al*. (2007) have found that 19.15%increase in crude protein content of cowpea after 28 h of sprouting. Uppal and Bains (2012) observed crude protein increase from 8 to 11 % after sprouting.

The study revealed that the highest calcium content (2.37) was produced by the grey variety which was sprouted for 8 days. Increase in calcium content may be attributed to the presence of calcium salts in sesame seeds that dissolve during sprouting process as also reported by Ranhotra *et al*. (1977). Varietal differences affected the amount of available potassium during sesame seed sprouting. Significantly highest potassium, magnesium and phosphorus content was produced by the grey variety which was sprouted for 8 days. This suggests that sprouting increased the potassium, magnesium and phosphorus content of sesame (Maria *et al.,* 2018).

Conclusions

The grey sesame variety sprouted for 8 days produced the best carbohydrate, protein and moisture contents. Moreover, highest crude fibre content was produced by the brown variety which was not sprouted whiles highest fat content was produced by the grey variety which was sprouted for 2 days. For the mineral composition, highest calcium, phosphorus and potassium content were produced by the grey variety which was sprouted for 8 durations whiles highest magnesium content (0.79) was produced by the brown variety which was sprouted for 2 durations. Sprouting durations and the varieties did not significantly influence sodium content of sprouted seeds of both grey and brown varieties. In conclusion, to obtain highest nutrients from sesame seeds, the grey variety should be sprouted for 8 days.

REFERENCES

Agrahar-Murugkar, D., Kokwaliwale, N., Kumar, M. and Gupta, C. (2013). Effect of sprouting on rheological properties of soy butter. LWT-*Food Science and Technology. 54: 95–100.*

Ahmed DM, Zahran HA, Zaher FA, Abd Ei-Hamid MA, Ei-Hamidi MA. (2018). Jatropha tree productivity, seed oil content and oil quality as feed stock for biodiesel production. *Bioscience Research* 15(3): 2134–2140.

Ali, A.S., and Elozeiri, A.A. (2017). Metabolic processes during seed germination. *Advances in seed biology*, *2017*, 141-166.

Association of Official Analytical Chemists (AOAC). (1990). Official methods of analysis.

Bedigian, D. (2004). History and lore of sesame in Southwest Asia. *Economic Botany*, *58*(3), 329-353.

Chakraborthy, G. S., Sharma, G., and Kaushik, K. N. (2008). Sesamum indicum: a review. *Journal of Herbal Medicine and Toxicology*, *2*(2), 15-19.

Chevance, F. F. V., Farmer, L. J., Desmond, E. M., Novelli, E., Troy, D. J. and

Chizzolini, R. (2000). Effect of some fat replacers on the release of volatile aroma compound from low- fat meat products. *Journal of Agricultural and Food Chemistry* 48(8): 3476-3484.

Dhingra, D., Michael, M., Rajput, H. and Patil, R. T. (2012). Dietary fibre in foods: a review. *Journal of Food Science and Technology* 49(3): 255-266.

Gharby, S., Harhar, H., and Charrouf, Z. (2017). Chemical characterization and oxidative stability of seeds and oil of sesame grown in Morocco. *Journal of the Saudi Society of Agricultural Sciences*, *16*, 105–111.

Girmay, A. B. (2018). Sesame production, challenges and opportunities in Ethiopia. *Vegetos-An International Journal of Plant Research*, *31*(1), 51.

Guillon, F., Auffret, A., Robertson, J. A., Thibault, J. F. and Barry, J. L. (1998). Relationships between physical characteristics of sugar beet fibre and its fermentability by human fecal flora. *Carbohydrate Polymers* 37(2): 185-197.

Hahm, T., Park, S., and Lo, Y. M. (2009). Effects of germination on chemical composition and functional properties of sesame (Sesamum indicum L.) seeds. *Bioresource Technology*, *100*, 1643–1647.

Zebib, H., Bultosa, G., and Abera, S. (2015). Physico-chemical properties of sesame (*Sesamum indicum* L.) varieties grown in Northern Area, Ethiopia. *Agricultural Sciences*, *6*(02), 238.

Jirapa, P., Normah, H., Zamaliah, M.M., Asmah, R. and Mohamad, K. (2001). Nutritional quality of germinated cowpea flour (*Vigna unguiculata*) and its application in home prepared weaning foods. *Plant foods Hum. Nutr*. 56: 203 –216.

Kwon TB (1994) Changes in rutin and fatty acids of buckwheat during germination. *Korean Journal of Food and Nutrition* 7(2):124–127

Liu, B., Guo, X., Zhu, K., and Liu, Y. (2011). Nutritional evaluation and antioxidant activity of sesame sprouts. *Food Chemistry*, *129*(3), 799-803.

Liu, C. L., Chen, Y. S., Yang, J. H., and Chiang, B. H. (2008). Antioxidant activity of tartary (Fagopyrum tataricum (L.) Gaertn.) and common (Fagopyrum esculentum Moench) buckwheat sprouts. *Journal of Agricultural and Food Chemistry*, *56*(1), 173-178.

Maria, M. F., and Victoria, A. T. (2018). Changes in Nutritional, Functional and Pasting Properties of Raw and Germinated Seeds of White Sesame (*Sesamum indicum* L.) Grown in Nigeria. *Acta Scientific Nutritional Health*, *2*(11), 7-15.

Megat, R. M. R., Azrina, A., and Norhaizan, M. E. (2016). Effect of germination on total dietary fibre and total sugar in selected legumes. *International Food Research Journal*, *23*(1), 257.

Mehta MB, Mehta B, Bapodra AH, Joshi HD (2007). Effect of sprouting and heat processing on protein, riboflavin, Vitamin C and niacin content in peas, cowpea, redgram and wheat. *Asian Journal of Home Science* 2(1and2):34–38

Nassar, A. G., AbdEl-Hamied, A. A. and El-Naggar, E. A. (2008). Effect of citrus by products flour incorporation on chemical, rheological and organoleptic characteristics of biscuits. *World Journal of Agricultural Sciences* 4(5): 612- 16.

Nkhata, S. G., Ayua, E., Kamau, E. H., and Shingiro, J.B. (2018). Fermentation and germination improve nutritional value of cereals and legumes through activation of endogenous enzymes. *Food science and nutrition*, *6*(8), 2446- 2458.

Nonogaki H, Bassel GW, Bewley J.D. (2010) Germination—Still a mystery. *Plant Science* 179:574–581

Onimawo IA, Asugo S (2004). Effects of germination on the nutrient content and functional properties of pigeon pea flour. *Journal of Food Science and Technology* 41(2):170–174

Osawa, T., Namiki, M., and Kawakishi, S. (1990). Role of dietary antioxidants in protection against oxidative damage. *Antimutagenesis and anticarcinogenesis mechanisms II*, 139-153.

Pastorello, E. A., Varin, E., Farioli, L., Pravettoni, V., Ortolani, C., Trambaioli, C., ... and Conti, A. (2001). The major allergen of sesame seeds (*Sesamum indicum*) is a 2S albumin. *Journal of Chromatography B: Biomedical Sciences and Applications*, *756*(1-2), 85-93.

Pusadkar, P. P., Kokiladevi, E., Bonde, S. V., and Mohite, N. R. (2015). Sesame (*Sesamum indicum* L.) importance and its high quality seed oil: a review. *Trends Bioscience*, *8*(15), 3900-3906.

Rababah T, Al-U'datt MU, Al-Mahasneh MA, Odeh A, Ajouly T, Feng H. (2017). Effect of processing and storage at different temperatures on the physicochemical and minerals content of sesame seeds and tehina. Bulgarian J Agric Sci 23(5): 851–859