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EFFECT OF FERMENTATION CONTAINERS ON THE CHEMICAL COMPOSITION OF FERMENTED SESAME (*Sesamum indicum L)* SEEDS

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ABSTRACT

The importance of utilizing oilseeds as complementary nutrient sources for human consumption has received considerable attention in recent years. There exists wide varieties of oil crops including sesame seed (*Sesamum indicum* L.), which are reported in literature to be rich in oil and nutrients; however, the presence of anti nutritional factors limits its uses. Processing grain using fermentation results in enhanced nutrition, stabilization of original raw materials, and detoxification of anti nutritional factors. There was lack of adequate traditional fermentation containers hence the need for use of some modern containers. This work, therefore, studied the effects of using banana leaf and plastic (high density polyethylene) bowl as containers for fermentation on the nutrients and anti nutritional factors of sesame seed. Samples were fermented separately using banana leaf and plastic bowl for seven days at temperature of 35 ± 2°C. Samples were drawn at intervals during fermentation to determine proximate composition, elemental concentrations and anti-nutritional factors concentrations using standard procedures. The pH decreased in the first 5 days and then increased as fermentation progressed coupled with a consistent rise in titratable acidity. Proximate analysis showed an increase in ash and crude fat contents with corresponding decrease in the carbohydrate and protein contents during fermentation. Protein ranged between 15.25% and 15.37% in banana leaf and plastic bowl respectively, compared to raw seed (26.20%). Fat increased from 51.02% in raw sesame to 60.20% and 59.33% in banana leaf and plastic bowl, respectively. However, fermented samples obtained from the plastic bowl had higher vitamin (thiamine and riboflavin) and minerals (calcium, phosphorus, potassium, magnesium, iron, selenium, zinc and manganese) in comparison to samples fermented in banana leaf. Fermentation in banana leaf and plastic bowl significantly reduced oxalate content of raw sesame by 35.40% and 29.12% respectively. In addition, phytate content was significantly reduced by 36.37% and 34.43% respectively. The present study showed that fermentation container had significant effect on nutritional composition during the fermentation of sesame seed.

Key words: Sesame Seed, Fermentation, Incubation, Composition

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INTRODUCTION

The importance of utilizing oilseeds as complementary nutrient sources for human consumption has received considerable attention in recent years. There is a wide variety of oil crops ranging from largely known and highly utilized ones like soya bean, palm kernel, groundnut, extra, to underutilized ones like walnut, locust bean, African oil bean, sesame seed, etc. Sesame (*Sesamum indicum* L., synonymous with *S.orientale* L., also known as sesamum, gingelly, sim sim, benniseed, and til) is probably the most ancient oilseed known and used by humans as a food source [1]. It has been cultivated for centuries, particularly in the developing countries of Asia and Africa. Nigeria produces about 90 thousand metric tonnes annually [2]. It is, however, given little attention in Nigeria as its utilization is restricted to producing regions; for the most part, the surplus crop is commercialized, bulked and exported with minimal processing limited to cleaning and drying. Lack of knowledge of the nutritional qualities of lesser known oil seed grown in developing countries like Nigeria is responsible for the poor utilization of these crops in different food formulations. The chemical composition of sesame shows that the seed is an important source of oil (44–58%), protein (18–25%), carbohydrate (13.5%) and ash (5%) [3].

Fermentation technologies play an important role in ensuring the food security of millions of people around the world, particularly the marginalised and vulnerable groups. This is achieved through improved food preservation, increasing the range of raw materials that can be used to produce edible food products and removing anti – nutritional factors to make food safe to eat [4]. Previous research work on oilseeds points to fermentation more responsible for providing nutritionally better product than the raw seeds and the enzymes, especially α- amylase aid hydrolysis of the seed macromolecules [5, 6]. The anti- nutritional factor phytic acid, from raw sesame seed meal, could be reduced below detection limit by fermentation with lactic acid bacteria (*Lactobacillus acidophilus*) according to Mukhopadhyay [7]. Traditional container such as banana (*Musa sapeinta*) leaf has been use since the earliest times for the fermentation of foods. However, they have poor barrier properties and are also unsuited to the needs of commercial production process. Modern technology has offered a wide range of materials that overcome the limitation from the use of leaves. Food grade polyethylene (plastic) is typically polymers of high molecular mass. Due to their relatively low cost, ease of manufacture, versatility, and imperviousness to chemicals, polyethylene are used in an enormous and expanding range of products. They have already displaced many traditional materials, such as paper; metal; glass; and ceramic, in most of their traditional uses.

Studies to design appropriate fermentation and storage techniques using different incubation materials to reduce the risk of mycotoxin contamination in sesame seed [8], optimization of enzymatic hydrolysis of defatted sesame flour by different proteases[9] and the effect of fermentation on the nutritive value of sesame seed meal in the diets for rohu, *Labeo rohita* (Hamilton), fingerlings have been investigated [7], yet there is dearth of information on the effects of fermentation container on the nutritional value of fermented sesame seed as the seeds were basically consumed roasted. This work therefore studied the effects of using banana leaf and plastic bowl

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as fermentation containers on the nutrients and anti nutritional factors of sesame seed in view of increased utilization.

MATERIALS AND METHODS

Preparation of sesame seeds

White variety of sesame seeds used in the present study was purchased from a local market at Kaduna in the Northern part of Nigeria and was transported to the laboratory in an airtight polythene bag. The mature, dry sesame seeds were sorted to remove infested seeds. The hulls contain high concentration oxalate and phytate which impact a slightly bitter taste to whole seed hence the need for dehulling prior to fermentation of sesame seeds The whole beans were dehulled by soaking in water (1: 5 w/v) ratio for 4 hr at temperature of 29± 2°C according to the method of Mohamed et al [10]. This time was adequate to sufficiently loosen the sesame seed, allowing hand stripping off of the coat. The ruptured seed coats were then removed by rubbing with palms and washing with cold water and drained. Dehulled seeds were divided into two parts, with one part subjected to fermentation while the other without further treatment served as control (raw sesame seed).

Fermentation of the sesame seed

The dehulled seeds were fermented using a previously described method [11]. The dehulled seeds were boiled for 6 hr to soften the cotyledon and cooled. The boiled seeds were divided into eight portions. Four portions were placed in separate clean banana leaf (*Musa sapeinta*); the remaining four portions were separately placed in plastic bowls with tight sealed lid and allowed to ferment at temperature of 35 ± 2 °C for 7 days. The fermenting seeds were collected at 1, 3, 5 and 7 days. The samples were oven dried at 105 °C for 12hr to bring an end to fermentation and analysed. Each experiment was replicated.

Determination of p^H and titratable acidity

The p^H and Titratable acidity were determined using chemical method of Achinewhu [12]**.** Ten grams of dried flour was mixed with 100ml distilled water. The mixture was allowed to stand for 15 minutes, shaken at 5 minutes intervals and centrifuged at 3000 rpm for 15 minutes using a Denley centrifuge (Model BS4402/D, Denley, England). The supernatant was decanted and its p^H was determined using a p^H meter (Model 3505, England). Ten ml aliquots (triplicate) were titrated against 0.1M NaOH using 1% phenolphthalein as indicator. Titratable acidity was expressed as g lactic acid/100g of sample and calculated using the formula:

$$TA = \frac{MNaOH \times ml\ NaOH \times 0.09 \times 100}{ml\ of\ sample)}$$

Where, TA = titratable acidity; MNaOH = Molarity of NaOH used; ml NaOH = amount (in ml) of NaOH used; 0.09 = equivalent weight of lactic acid

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Proximate composition

The proximate chemical compositions of the samples were determined using the standard procedure [13]. The crude protein content was calculated by multiplying the total nitrogen by a factor (by convention, 6.25 for oilseeds). The carbohydrate content was estimated by difference.

Determination of mineral contents

Ash was determined by combustion of the sample in a muffle furnace at 550°C for 12 h [13]. The residue was dissolved in HNO_3 with 50 g/l of $LaCl_3$ and the mineral constituents (Ca, K, Mg, Na, Fe, Zn and Mn) were analysed separately, using an atomic absorption spectrophotometer (Hitachi Z6100, Tokyo, Japan). Phosphorus content (P) was determined by the phosphomolybdate method [13].

Determination of vitamin content

Thiamine (vitamin B_1) and riboflavin (vitamin B2) were determined by using spectrophotometric method [14]. Thiamine content was determined by weighing 0.5g of the sample and adding 30ml Dichloroethane and 30ml 0f 30% HCl (ratio1:1). Then 50ml Ammonium Hydroxide solution was added. The solution was then filtered using Whatman No1 filter paper. Then the absorbance was read on a spectrophotometer (Spectronic 20 model) at 415nm.

Riboflavin content was determined by weighing 1g of the sample and adding 50ml of 50% Methanol and 50ml of 17% Sodium Carbonate. This is the extraction. Then the absorbance was read on a spectrophotometer at a wavelength of 415nm.

Determination of Anti-nutritional Factors

The phytate content was determined by the chemical method described by Maga [15]. Two grams of each finely ground sample was soaked in 20ml of 0.2 N HCl and filtered. After filtration, 0.5 ml of the filtrate was mixed with 1ml ferric ammonium sulphate solution in a test tube, boiled for 30 min in a water bath, cooled in ice for 15 min and centrifuged at 3000 rpm for 15 min. One millilitre of the supernatant was mixed with 1.5ml of 2, 2- pyridine solution and the absorbance measured in a spectrophotometer at 519nm. The concentration of phytic acid was obtained by extrapolation from a standard curve using standard phytic acid solution.

The titration method was used to determine the oxalate content according to Day and Underwood [16]. To 1 g of the ground powder, 75 ml of 15N H_2SO_4 was added. The solution was carefully stirred intermittently with a magnetic stirrer for 1 h and filtered using Whatman No 1 filter paper. 25 ml of the filtrate was then collected and titrated against 0.1 N $KMnO_4$ solution till a faint pink colour appeared that persisted for 30s.

Statistical analysis

Determinations were carried out in triplicates and .the error reported as standard deviation from the mean. One-way analysis of variance (ANOVA) was performed and the least significant differences were calculated with the SPSS version 16.00 Software. Significance was accepted at $p< 0.05$ levels.

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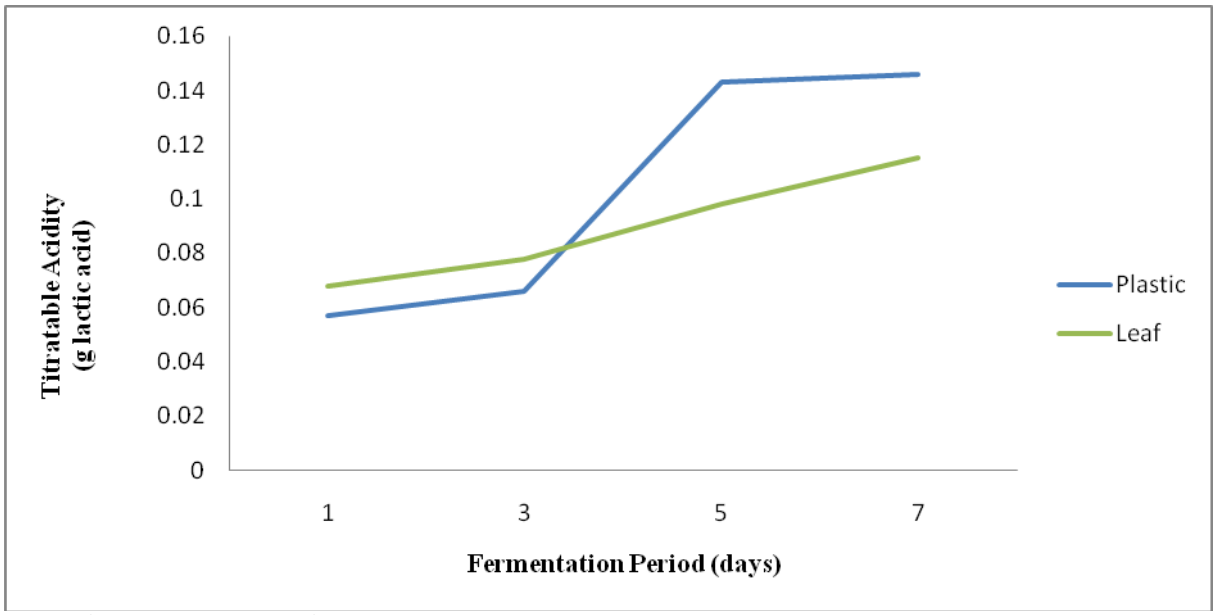
RESULTS

Titratable acidity

Figure 1 shows the total titratable acidity of the raw and fermented sesame seed. Fermentation caused consistent increases in titratable acidity of the samples from 0.057 to 0.146 g lactic acid/100 g for the sesame seeds fermented in plastic bowl and from 0.068 to 0.115 g lactic acid/100 g sample for the sesame seed fermented in banana leaf, respectively.



Number of samples assayed at each fermentation day
Day 1- BA1, PL1
Day 3- BA3, PL3
Day 5- BA5, PL5
Day7- BA7, PL7

Figure1: Changes in titratable acidity of Sesame seeds during fermentation

pH

In sesame seeds fermented after boiling, the pH decreased in the first 5 days of fermentation in the two fermentation containers used but increased towards the 7th day fermentation period as shown in Figure 2.

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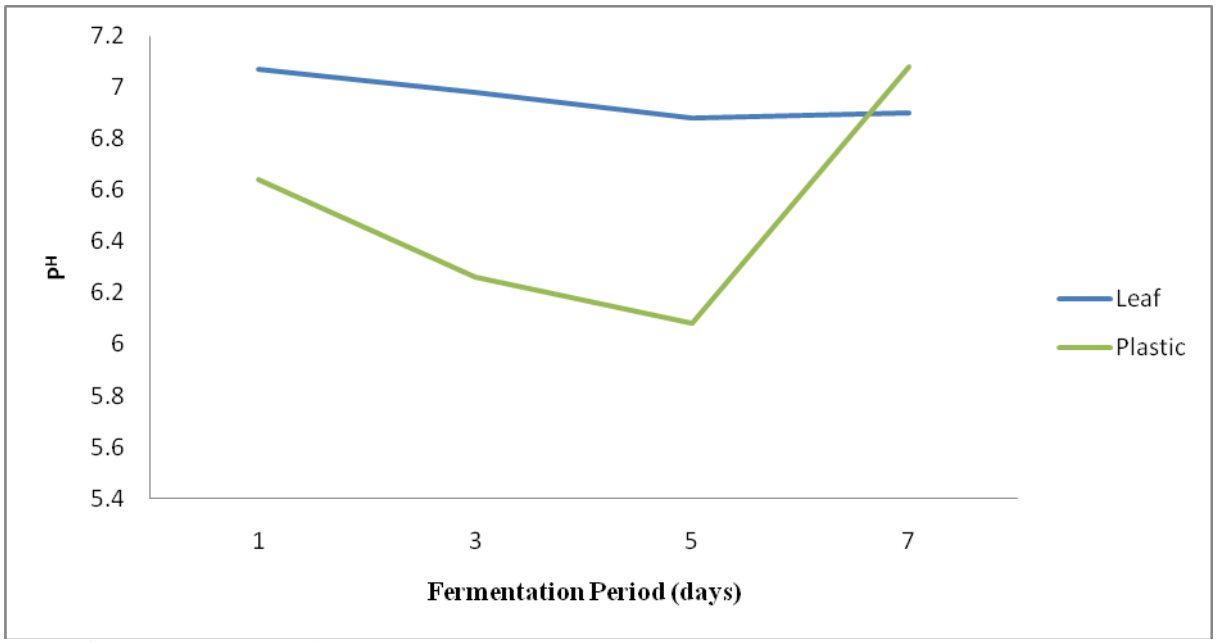

Number of samples assayed at each fermentation day
Day 1- BA1, PL1
Day 3- BA3, PL3
Day 5- BA5, PL5
Day7- BA7, PL7

Figure 2: Changes in pH of Sesame seeds during fermentation

Proximate composition

The pattern of changes in the proximate chemical composition of sesame seed during fermentation is shown in Table 1. Fermentation caused significant ($P<0.05$) reduction in protein content. Crude protein decreased to about15.25% and 15.37% in samples fermented in banana leaf and plastic bowl respectively after 7 days. High crude fat values 51.02% were reported for the raw sesame seeds. However, fermentation with banana leaf and plastic bowl cause significant increase in the fat content with the values of 60.20 and 59.33%, respectively.

Carbohydrate content also decreased from 9.93 % to 9.11% in samples fermented in banana leaf and 10.47 to 9.90% for samples in plastic bowl, respectively compared to raw seed (13.81%). Ash contents of raw sesame seed was 4.80%, and was affected when the seeds were fermented with both containers. However, samples fermented in plastic bowl had significant higher carbohydrate after fermentation compared to samples from banana leaf. Crude fibre content of raw sesame seed was 4.73%. Crude fibre values decreased significantly for the fermented sesame seeds. Decrease in crude fibre from 4.42 to 4.31% was recorded for samples fermented in banana leaf while a range of 4.55 to 4.20% was recorded for samples in plastic bowl after fermentation.

Mineral composition

Considering each fermentation container, plastic bowl proved to have better mineral retention capacity than banana leaf as indicated in Table 2. Calcium was in the range

of (474-479 mg/100g) and (513-521mg/100g) in samples fermented in banana leaf and plastic bowl, respectively. The same trend was observed in the potassium content. However, there was significant reduction in phosphorus and magnesium values after 24 hr fermentation in samples fermented in banana leaf compared to the raw seed followed by an increase after 48 hr until the end of the fermentation period.

Vitamins and anti nutrients

Fermentation in the two containers caused a significant rise in thiamine and riboflavin contents compared to that of raw seeds as shown in Table 3. Significant increase was noticed after 24 hr fermentation and further increase as fermentation progressed. Fermentation in both containers lowered the concentrations of phytate and oxalate in sesame seeds as indicated in Table 3. At the end of the fermentation process, phytate was reduced to 11.02mg/100g and 10.33mg/100g in samples fermented in banana leaf and plastic bowl, respectively. Increase in fermentation time also reduced the anti nutritional factor concentration significantly ($p<0.05$) in the fermentation containers.

DISCUSSION

Titratable acidity

Titratable acidity measures total organic acid that is present in the samples. The measurement is important because acidification is the key mechanism during fermentation. There was an increase in the titratable acidity of samples fermented in banana leaf and plastic bowl with increasing fermentation time (Figure 1). Leaching out of the acidic constituents in to soaking water before dehulling and hydrolysis of lipids, proteins and carbohydrates by activated indigenous enzymes in the seeds as well as by the enzymes of the fermentative micro-organisms may be responsible for the changes observed in acidity. Acid production has been reported to be responsible for product stability and flavour development [17].

p^H

The fermentation of sesame seed has been described as lactic acid fermentation [18]. The lower p^H observed during the first 5 days could be as a result of the activities of micro-organisms which might have started fermentation by hydrolysing available carbohydrate to lactic acid before embarking on proteolysis of available protein towards the end of fermentation process. Thus, the acid produced initially lowers the p^H and subsequent increase in p^H of the fermenting mash of sesame may be due to the abundant increase of ammonia during the later stages of fermentation. The fermentation of sesame cake to produce *sigha* (a Sudanese food) also resulted in initial gradual decrease in p^H till the fourth day of fermentation followed by a rise on the fifth day [19].

Proximate composition

The pattern of changes in the proximate chemical composition of sesame seed during fermentation is shown in Table 1. The physical observation of fermenting mash was dark brown appearance which is mucilaginous slime, moulding the cotyledon together. Fermentation of the seeds resulted in significant ($p< 0.05$) decrease of nutrients from the raw seeds. The value of 26.20 % obtained for protein content of

raw seed is higher than the value found in the literature for some well known oil seed such as, melon seed (15.22%). The principal reason for the reduction in protein content of fermented samples would appear to be in the preparation of the seed prior to fermentation, which in West Africa involves boiling for several hours in water until soft. Such pre-treatment may alter the course of fermentation by two mechanisms- first, by rendering protein more available for degradative attack by micro organisms leading to escape of the by product of metabolic deamination and second, by effectively eliminating much of the heat-sensitive indigenous micro flora [19]. However, the protein loss was much more in samples fermented banana leaf compared to plastic bowl. This could be as a result of leaching of some proteins into the porous banana leaf. Further decrease as fermentation progresses indicate high loss of nitrogen during the process. This result is similar to the work on the effect of fermentation on the nutritive value of *B. Eurycoma* "Achi" where a decrease in protein content from 3.35% to 2.29% was reported [20]. High crude fat values were reported for the raw sesame seeds and the value is comparable to other oil seeds such as linseed 40%, cotton seed 24% and groundnut 46% [21]. This indicated that *Sesamun indicum* L. seeds are good source of oil which makes it a good source of vegetable oil for nutritional and industrial purposes. The increase in fat content during fermentation agrees with the findings on fermented products [12].

A decrease in carbohydrate content of samples fermented in both fermentation containers was obvious, because it was used up as the main source of energy during fermentation. Fermentation significantly ($p<0.05$) increased the ash content of the oil bean seeds, reflected in the increase in the concentrations of some major minerals like phosphorus and calcium (Table 2). This increase may be due to contribution by fermenting microorganisms [19]. The same trend was observed on the effect of fermentation on the nutrient status of locust bean where an increase of about 30% in ash content was recorded after fermentation [22].

Mineral composition

Fermentation resulted in higher amount of mineral elements in the two fermentation containers throughout the period. However, the rise in these essential minerals was significantly higher in samples from plastic bowl compared to banana leaf. The lesser values reported in samples fermented in banana leaf could be as a result of leaching. Mineral content also increased as fermentation progressed in both containers. This observed increase in mineral composition may be due to the contribution from fermentation microorganisms. The mineral composition showed that calcium was the predominant macro mineral followed by potassium, magnesium and phosphorus. Micro elements such as iron, selenium, zinc and manganese were present in comparatively low concentrations. The mineral content of the raw and fermented sesame seeds were quite higher than that recorded for raw coconut, while studying the effect of roasting on the chemical composition of coconut (*Cocus nucifera*) seed flour and oil [23]. The fermented samples could therefore be referred to as good sources of Calcium, Magnesium, Potassium and Phosphorus. The sesame seeds are high in phosphorus and calcium, the minerals which are necessary for teeth and bone development in children. Initial soaking and cooking could have led to the decrease of some of some of the minerals by leaching and subsequent increment of some could be

because of the conversion of the insoluble reserve foods by enzymes during fermentation [24]. Only samples fermented in plastic bowl showed consistently significant increase in mineral contents compared to raw sesame seed.

Considering other minor mineral elements, samples fermented in plastic bowl also had higher values of iron, selenium, zinc and manganese compared to those samples fermented in banana leaf possibly due to porous nature of the leaf as some of the "sauce" or juices from food item may seep through. Banana leaf also contain large amount of polyphenol which bind with nonheme iron *in vitro* in model systems, possibly reducing its absorption [25].

Vitamins and anti-nutrients

Fermentation resulted in significantly higher thiamine and riboflavin in samples from plastic bowl compared to banana leaf. The lesser values in samples fermented in banana leaf could also be as a result of leaching. The vitamin content of the seed was however low. Fermentation has been reported to increase the levels of vitamins B and C in weaning food [26].

The anti-nutritional factors are generally reported to have the capacity of retarding growth and lowering digestibility and absorption of important dietary nutrients. Phytates are known to chelate some divalent metals, notably Ca, Mg, Zn and Mn, making them metabolically unavailable [27]. The reduction in phytate level could be interpreted as the main reason behind the observed increases in the concentrations of minerals in the fermented samples (Table 2). The anti-nutritional factor, phytic acid, from raw sesame seed meal, could be reduced below detection limit by fermentation with lactic acid bacteria [28]. The effect of fermentation on phytic acid and oxalic acid may be due to the activity of enzymes like phytase and oxidase produced by fermenting micro flora [15].

CONCLUSION

This work has shown that significant improvement in the nutritional composition of *Sesamum indicum* seed can be attained through fermentation of the seeds in banana leaf and plastic (high density polyethylene) bowl. However fermentation in plastic bowl offers greater nutritional advantages over its counterpart.

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Table 1: Mean[K] Proximate composition of raw and fermented sesame (dry matter basis)

Samples	Moisture(%)	Ash (%)	Fibre (%)	Fat (%)	Protein (%)	Carbohydrate*
RSS	4.57[a]±0.03	4.80[a]±0.05	4.73[d]±0.04	51.02[a]±0.08	26.20[e]±1.14	13.81[f]±0.02
WBA1	9.14[b]± 0.01	7.20[b]±0.09	4.42[b]±0.06	58.17[c]±0.15	16.65[d] ±0.40	9.93[c] ±0.01
WBA3	9.41[d] ±0.11	7.31[c]± 0.02	4.41[b]±0.01	58.33[c]±0.22	16.43[c]±0.04	9.61[b]± 0.01
WBA5	9.32[c]±0.04	7.31[c]± 0.10	4.30[b]±0.15	59.27[d]±0.24	16.16[b]±0.20	9.15[a]± 0.07
WBA7	9.30[c] ± 0.05	7.33[c]±0.03	4.31[b]±0.03	60.20[e]±0.23	15.25[a]±0.37	9.11[a]± 0.20
WPL1	9.29[c] ± 0.08	7.25[c]±0.01	4.55[c]±0.05	57.77[b]±0.20	16.18[b]±0.10	10.47[e]±0.08
WPL3	9.32[c] ± 0.03	7.27[c]±0.10	4.31[b]±0.02	58.18[c]±0.07	16.21[b]±0.03	10.22[d]±0.01
WPL5	9.44[d]±0.06	7.32[c]±0.03	4.21[a]±0.02	58.27[c]±0.15	16.04[b]± 0.04	10.21[d]±0.01
WPL7	9.32[c] ±0.03	7.38[d]±0.03	4.20[a]±0.05	59.33[d]±0.35	15.37[a]±0.18	9.90[c]±0.02

Note

* Calculated by difference

K - Mean of three replicates.

Different superscripts between columns indicate a significance ($p \leq 0.05$) difference.

Legend: RSS: Raw sesame seed; BA1: Sesame seed fermented in banana leaf day1; BA3: Sesame seed fermented in banana leaf day3 ; BA5 : Sesame seed fermented in banana leaf day5; BA7: Sesame seed fermented in banana leaf day7; PL1: Sesame seed fermented in plastic bowl day1; PL3: Sesame seed fermented in plastic bowl day3; PL5: Sesame seed fermented in plastic bowl day5; PL7: Sesame seed fermented in plastic bowl day7.

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Table 2: Mean[K] Mineral composition of raw and fermented sesame seed

Samples	Ca	P	K	Mg	Fe	Se	Zn	Mn
RWS	443.67[a]±3.20	422.67[d]±0.5	321.33[a]±1.0	341.3[c]±1.50	6.13[a]±0.5	0.023[a]±0.0	7.66[a]±0.01	1.43[a]±0.3
WBA1	474.00[c]±1.00	361.3± 1.16	423.22[b]±1.02	326.0[a]±1.00	6.22[a]±0.3	0.053[b]±0.00	8.21[b]±0.01	3.53[b]±0.15
WBA3	471.33[b]±1.16	364.33[a]±1.89	426.67[b]±0.58	339.33[b]±1.16	6.27[a]±0.02	0.063[c]±0.00	8.31[b]±0.02	3.63[b]±0.12
WBA5	473.67[c]±0.58	370.67[b]±0.58	433.00[c]±2.00	341.00[c]±1.00	6.23[a]±0.03	0.067[c]±0.00	8.53[c]±0.12	3.70[b]±0.12
WBA	7479.00[d]±1.00	372.33[b]±1.16	445.67[d]±0.58	342.33[c]±1.16	6.31[a]±0.03	0.063[c]±0.01	8.57[d]±0.06	3.77[b]±0.06
WPL1	513.33[e]±0.58	433.67[e]±1.16	444.00[d]±1.00	342.7[c] ±0.58	6.31[a]±0.01	0.053[b]±0.00	9.12[d]±0.03	4.05[c]±0.05
WPL3	515.66[f]±0.58	439.7[e]± 1.53	449.33[e]±1.16	347.3[d] ±1.16	6.37[a]±0.02	0.053[b]±0.00	9.34[e]±0.04	4.30[d]±0.10
WPL5	517.67[g]±1.16	442.33[e]±1.15	450.00[e]±1.00	352.00[e]±1.00	6.37[a]±0.02	0.067[c]±0.01	9.47[f]±0.06	4.37[d]±0.06
WPL7	521.33[h]±1.37	451.67[f]±6.93	450.67[e]±5.13	359.7[f] ±0.58	6.30[e]±0.12	6.41[a]±0.01	0.07[d]±0.00	9.63[g]±0.12

Note

Different superscripts between columns indicate a significance ($p \leq 0.05$) difference.

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Table 3: Mean[K] Vitamins and anti nutrients composition of raw and fermented sesame seed

	Vitamins (mg/100g)		Anti nutrients (mg/100g)	
Samples	Thiamine	Riboflavin	Oxalate	Phytate
RWS	$0.76^{d} \pm 0.02$	$0.31^{a} \pm 0.01$	$85.67^{i} \pm 0.58$	$30.00^{f} \pm 3.00$
WBA1	$0.67^{b} \pm 0.03$	$0.34^{b} \pm 0.02$	$52.83^{h} \pm 2.25$	$21.10^{e} \pm 0.17$
WBA3	$0.70^{c} \pm 0.01$	$0.39^{b} \pm 0.01$	$50.17^{g} \pm 0.76$	$16.17^{c} \pm 0.29$
WBA5	$0.71^{c} \pm 0.01$	$0.37^{b} \pm 0.03$	$45.33^{e} \pm 0.58$	$14.32^{b} \pm 0.59$
WBA7	$0.72^{c} \pm 0.03$	$0.38^{c} \pm 0.02$	$30.33^{b} \pm 0.09$	$11.02^{a} \pm 0.02$
WPL1	$0.91^{e} \pm 0.02$	p$0.44^{d} \pm 0.01$	$52.67^{f} \pm 0.76$	$20.67^{e} \pm 0.58$
WPL3	$0.97^{f} \pm 0.01$	$0.47^{d} \pm 0.01$	$43.33^{d} \pm 0.75$	$17.33^{d} \pm 0.58$
WPL5	$0.97^{f} \pm 0.01$	$0.57^{e} \pm 0.04$	$40.16^{c} \pm 0.76$	$15.27^{c} \pm 0.25$
WPL7	$0.98^{f} \pm 0.01$	$0.57^{e} \pm 0.03$	$24.95^{a} \pm 0.58$	$10.33^{a} \pm 0.50$

Note

Different superscripts between columns indicate a significance ($p \leq 0.05$) difference.

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