

EFFECT OF PROCESSING ON SOME MINERALS, ANTI-NUTRIENTS AND NUTRITIONAL COMPOSITION OF SESAME (*SESAMUM INDICUM*) SEED MEALS.

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ABSTRACT

Raw, cooked and toasted meals from Sesame (*Sesamum indicum*) seeds were analysed for proximate, mineral and anti-nutrient composition and the changes accompanying chemical composition when processing sesame seedmeal were investigated. There was significant ($P<0.05$) variation in the crude protein, crude lipid, crude fibre and ash content of undefatted and defatted sesame seed meal. Defatting the dehulled samples of the sesame seed meal increased its protein contents. There was significant ($P<0.05$) increase in protein content of the cooked and toasted seed meal when compared with that of the raw sample. While magnesium, sodium and potassium were the most abundant macro minerals in sesame seedmeal, Iron was the most abundant micro mineral in sesame seed meal used. A significant ($P<0.05$) reduction was observed in the mineral composition with processing time. As was observed in the raw samples, copper was not detected in the sample cooked and toasted for 30 minutes. A reduction in mineral contents of the cooked samples was observed. Raw sesame seed meal contains the highest level of anti-nutrients with respect to Trypsin Inhibitor (TIA), lectin, tannin, phytin, saponin and oxalate. Cooking and toasting reduced anti-nutrient contents of sesame seedmeal at lower cooking and toasting time. TIA and lectin contents were removed at higher cooking time while only lectin content was completely eliminated at 30 minutes toasting time.

KEYWORDS

Processing minerals, anti-nutrients, *sesamum indicum*, seed meals.

INTRODUCTION

Plant oilseeds and pulses constitute a readily available source of dietary protein for use within compound and aquafeed. (Tacon, 1997) but their use within compound aqua feed is restricted by the presence of one or more endogenous antinutrients (NRC, 1993). Sesame (*Sesamum indicum*) is one of the important annual crops of the world, grown for oil (Salunkhe *et al.*, 1991). Sesame seeds are rich sources of protein, minerals such as calcium and phosphorus (Salunkhe *et al.*, 1991). Hence they have nutrient quality favorably comparable with other oilseeds and legumes. Like all other oilseeds, their use as fish or other animals feed ingredient is limited by the presence of anti-metabolites primarily; trypsin inhibitor, phytate (Salunkhe *et al.*, 1991, Smith, 1968, Agren and Lieden, 1968), oxalate, tannin (Narasinga Rao, 1985) and phytate (Tacon, 1997). Makkar and Becker 1999 observed that to evaluate an unknown seed or seed meal, it is imperative to have a detailed description of its chemical and nutritional properties, to obtain knowledge on acceptability and utilization by livestock, to investigate the presence of toxins and anti nutritional factors and to develop processes to detoxify deleterious factors present and finally to utilize the detoxified product for animal diets. Processing oil seeds and other plant protein to remove bioactive compound that may negatively affect their utilisation as component of animal feed are always accompanied by changes in their nutritional composition. This study therefore aimed at establishing such chemical changes as accompanying cooking and toasting raw, defatted dehulled sesame seed meals.

MATERIALS AND METHODS

PROCESSING OF SUNFLOWER AND SESAME SEED

The dehulled seedmeal were obtained from a farm in Kebbi State. They were processed as follow.

Raw Sesame Samples: These were prepared by grinding the samples in a laboratory mill and then mechanically defatted by the use of locally made screw press.

Cooked sesame samples: Three batches of sesame seeds were put in boiling water (100⁰C) for 10, 20 and 30 minutes to serve as processing time interval. They were dried, milled, and mechanically defatted using locally made screw press and designated as C₁₀, C₂₀ and C₃₀ respectively according to their time of processing.

Toasted sesame and sunflower seed sample: Three batches of sesame seeds were put in a pyrex beaker and heated at 180⁰C for 5, 10, and 15 minutes respectively. The toasted seeds were ground, and mechanically defatted using locally made screw press and designated as T₅, T₁₀, and T₁₅ respectively; according to time of processing.

Chemical Analysis

The proximate composition of dehulled defatted sesame seed meal for moisture, fat, ash, protein and fibre were carried out in triplicate using the methods described by Association of Analytical Chemist (1991). Nitrogen free extract was estimated by difference.

Macro and micro minerals were analysed from solutions obtained by first dry –ashing the

sample at 525⁰C and dissolving in volumetric flasks using distilled, de-ionised water with a few drops of concentrated hydrochloric acid. Sodium and potassium were determined using a flame photometer (corning, UK, Model 405), phosphorus was determined colorimetrically using a Spectronic 20 (Gallen Kamp, UK) as described by Pearson 1976. All other minerals were determined using atomic absorption spectrophotometer (PYE Unicomb, UK, Model SP9).

Trypsin Inhibitory Activity (TIA) was expressed in terms of the extent to which an aqueous extract of the flours inhibited the action of bovine trypsin on the substrate (Benzoyl – DL – arginine – p nitroanilide hydrochloride, BAPNA). TIA was subsequently determined spectrophotometrically as described by Smith *et al.* (1980).

Haemagglutinin was extracted from the defatted Sunflower and sesame flour by the four- step method of Huprikar and Sohoni (1965). The haemagglutinating activities of the extract will then be determined using 0.25% saline – washed trypsinizing erythrocytes in a two – fold dilution technique.

Phytin was determined using a combination of two methods. Extraction and precipitation of phytate was carried out, while iron in the precipitate was determined by the method of Mackower (1970). Phytic acid and phytin- phosphorus contents was determined according to the method of Young and Greaves (1940). Phytin-Phosphorus was calculated as a percentage of total phosphorus.

Hydrolysable tannin was determined as tannic acid, following the procedure of Makkar (1994).

STATISTICAL ANALYSIS

All determinations were conducted in triplicates and the means $\pm$ SD of three values were reported. Data were suggested to analysis of variance (ANOVA) using SPSS 13.0 version. Duncan Multiple Range Test was used to separate significant differences among treatment means.

RESULTS

PROXIMATE COMPOSITION

Data on the proximate composition of raw and processed dehulled defatted sesame seedmeal are presented in Table 1. There was significant difference ($P < 0.05$) in the crude protein, crude lipid, crude fibre and ash content of the dehulled undefatted and dehulled defatted sample of sesame seed meal. Defatting the dehulled seed increased the crude protein value significantly. There was a decrease in the crude protein content of the seed meals with cooking time and toasting time but not T₁₅.

Table 1. PROXIMATE COMPOSITION (g/100g) OF SESAME SEEDMEAL

	Raw whole seeds	Defatted raw seeds	C ₁₀	C ₂₀	C ₃₀	T ₅	T ₁₀	T ₁₅
Moisture	8.5 $\pm$ 0.18 d ^e	8.39 $\pm$ 0.25 ^e	9.1 $\pm$ 0.19 ^{ab}	8.97 $\pm$ 0.23 ^{abc}	9.28 $\pm$ 0.21 ^a	8.7 $\pm$ 0.23 ^{cde}	8.58 $\pm$ 0.23 ^{cde}	8.80 $\pm$ 0.15 ^{bcd}
Crude protein	21.78 $\pm$ 1.47 ^e	42.21 $\pm$ 1.89 ^{abc}	40.39 $\pm$ 1.64 ^{bc}	38.36 $\pm$ 1.94 ^{cd}	35.83 $\pm$ 1.97 ^d	42.84 $\pm$ 3.92 ^{ab}	44.76 $\pm$ 1.25 ^a	41.37 $\pm$ 2.48 ^{abc}
Crude lipid	46.5 $\pm$ 1.01 ^a	15.92 $\pm$ 1.61 ^b	11.90 $\pm$ 0.28 ^{cd}	12.83 $\pm$ 0.22 ^c	12.58 $\pm$.81 ^{cd}	10.76 $\pm$ 0.61 ^{de}	10.89 $\pm$ 1.07 ^{cde}	9.31 $\pm$ 1.78 ^e
Crude fibre	2.81 $\pm$ 0.75 ^b	5.48 $\pm$ 0.69 ^a	5.38 $\pm$ 0.40 ^a	6.22 $\pm$ 0.70 ^a	5.41 $\pm$ 1.26 ^a	5.76 $\pm$ 1.02 ^a	6.88 $\pm$ 0.92 ^a	7.22 $\pm$ 1.59 ^a
Ash	6.36 $\pm$ 0.88 ^d	7.27 $\pm$ 0.91 ^d	11.28 $\pm$ 1.05 ^{bc}	10.38 $\pm$ 1.63 ^c	12.28 $\pm$ 0.53 ^b	11.88 $\pm$ 0.94 ^{bc}	12.33 $\pm$ 0.42 ^{bc}	14.02 $\pm$.67 ^a
NFE	14.04 $\pm$ 1.98 ^d	19.97 $\pm$ 3.61 ^{abc}	22.02 $\pm$ 3.04 ^{abc}	22.02 $\pm$ 3.04 ^{ab}	24.62 $\pm$ 1.82 ^a	18.18 $\pm$ 6.4 ^{bcd}	16.76 $\pm$ 1.64 ^{cd}	19.28 $\pm$ 1.56 ^{abcd}

Figures in each row with different superscript are significantly different ($P < 0.05$) from each other

MINERAL COMPOSITION

The mineral composition of raw and processed dehulled defatted sesame seed meal are shown in Table 2. There were significant differences ($P<0.05$) in the mineral composition between the raw and the processed. While magnesium, sodium and potassium were the most abundant macro minerals in sesame seedmeal. Iron was the most abundant micro mineral in the two seed meal. A significant ($P<0.05$) reduction was observed in the mineral composition with processing time when compared with raw copper were not detected in the sample cooked and toasted for 30 minutes.

Table 2: MINERAL COMPOSITION (PPM) OF SESAME SEEDMEAL

	RAW	C ₁₀	C ₂₀	C ₃₀	T ₅	T ₁₀	T ₁₅
Potassium	537.21 ± 0.29 ^a	239.36 ± 1.07 ^d	368.82 ± 0.63 ^b	165.96 ± 0.64 ^b	328.07 ± 0.003 ^c	228.86 ± 0.39 ^f	224.78 ± 0.04 ^c
Calcium	368.76 ± 1.25 ^a	257.25 ± 2.01 ^c	295.10 ± 1.71 ^b	153.63 ± 0.12 ^f	260.01 ± 0.004 ^d	274.06 ± 0.002 ^c	261.86 ± 0.01 ^d
Sodium	764.95 ± 7.76 ^a	352.24 ± 1.42 ^d	406.12 ± 0.79 ^b	357.29 ± 0.10 ^d	380.41 ± 0.03 ^c	338.18 ± 0.003 ^c	356.23 ± 0.02 ^d
Magnesium	672.45 ± 20.94 ^a	296.37 ± 1.12 ^d	341.51 ± 0.56 ^b	205.47 ± 0.32 ^c	298.93 ± 0.75 ^f	300.0 ± 0.002 ^d	325.53 ± 0.004 ^c
Zinc	8.64 ± 0.35 ^a	1.27 ± 0.03 ^c	2.45 ± 0.44 ^d	3.28 ± 0.11 ^c	5.17 ± 0.002 ^b	2.98 ± 0.006 ^c	2.31 ± 0.009 ^d
Iron	6.99 ± 0.52 ^a	6.25 ± 0.64 ^b	4.97 ± 0.12 ^d	5.41 ± 0.07 ^c	4.03 ± 0.12 ^c	3.65 ± 0.003 ^f	4.19 ± 0.01 ^a
Copper	0.54 ± 0.03 ^a	0.23 ± 0.03 ^b	0.26 ± 0.03 ^b	ND	0.51 ± 0.02 ^a	0.23 ± 0.002 ^b	ND

Figures in each row with different superscript are significantly different ($P<0.05$) from each other

ANTI-NUTRIENTS COMPOSITION

The anti-nutrients composition of raw and processed dehulled defatted sesame seed meal are shown in Table 3. There were significant differences ($P<0.05$) in the anti-nutrients composition between the raw and the processed. A reduction trend was observed in the level of anti-nutrients in the various samples with processing time.

Table 3: ANTI-NUTRIENT COMPOSITION OF RAW AND PROCESSED SESAME SEEDMEALS

	RSM	CSM ₁₀	CSM ₂₀	CSM ₃₀	TSM ₅	TSM ₁₀	TSM ₁₅
TIA mg/g	0.29 ± 0.01 ^a	0.15 ± 0.03 ^b	0.06 ± 0.04 ^c	ND	0.10 ± 0.00 ^c	0.09 ± 0.00 ^c	0.08 ± 0.00 ^c
Lectin %	0.27 ± 0.01 ^a	0.15 ± 0.02 ^b	0.07 ± 0.02 ^c	ND	0.04 ± 0.01 ^c	0.02 ± 0.00 ^c	ND
Tannin mg/100g	5.62 ± 0.32 ^a	3.96 ± 0.30 ^b	1.54 ± 0.30 ^d	0.49 ± 0.20 ^c	2.19 ± 0.01 ^c	1.83 ± 0.01 ^{cd}	1.81 ± 0.01 ^{cd}
Phytin mg/100g	25.05 ± 4.6 ^a	17.8 ± 0.99 ^b	16.45 ± 1.77 ^{bc}	11.50 ± 2.40 ^{cd}	11.34 ± 0.01 ^{cd}	10.92 ± 0.02 ^c	9.37 ± 0.01 ^d
Saponin %	4.97 ± 0.06 ^c	2.01 ± 0.23 ^c	1.40 ± 0.19 ^c	1.61 ± 0.52 ^c	3.54 ± 0.01 ^a	2.71 ± 0.31 ^b	1.90 ± 0.01 ^c
Oxalate mg/100gm	15.66 ± 0.45 ^a	8.45 ± 0.47 ^{bc}	8.19 ± 0.06 ^c	4.68 ± 0.08 ^d	9.40 ± 0.02 ^b	8.60 ± 0.78 ^{bc}	5.11 ± 0.23 ^d

Figures in each row with different superscript are significantly different ($P<0.05$) from each other.

The level of anti-nutrients in the raw samples of sesame seedmeal with respect to TIA, Lectin, Tannins, Saponins, oxalates were significantly ($P<0.05$) higher than that of the processed samples of the same seedmeal. A reduction trend was observed in the level of antinutrients in the various samples with processing time. The TIA and Lectin content of sesame seedmeal was completely eliminated when the seed was cooked for 30 minutes. Only toasting at 15 minutes completely removed the Lectin contents of the meal.

DISCUSSION

The value of proximate composition of raw undefatted sesame seed agrees with the findings

of Joshi (1961); Smith (1971); Gopalan *et al.*, (1982), Weiss (1983). The defatted meal or cakes have a high content of protein. The result of proximate composition of defatted sesame seed meal was closely comparable with that of Ramachandra *et al.* (1970) who worked on the effect of dehulling and method of oil extraction on the composition of sesame flour and cake. Lower crude protein in cooked sesame seed meal might be as a result of leaching of soluble component of the protein into cooking water. Adeparusi (2001) made similar observation when autoclaving lima beans, *Phaseolus lunatus* L.

Higher content of macro-mineral potassium, sodium, calcium and magnesium in sesame seed meal recorded in this study agrees with earlier works by Joshi 1961, Agren and Gibson 1968, Gopalan *et al.* 1982 Weiss (1983) Smith 1971, Adam 1975.

The reduction in the TIA of sesame seedmeal recorded in this study for the two processing technique employed agrees with the work of Norton 1991 who recommended moist heat treatment (autoclaving for 15-30 minutes as a means of reducing the amount of TIA in seedmeal below critical level. The critical level as explained by Francis *et al.*, 2001 is the level of TIA at which most cultured fish and other farm animals will be able to compensate for the presence of TIA by increasing trypsin production within their system and this is below 5 mg/g. The optimum level for the destruction of TIA has been reported to be between 80 and 90% equivalent to a dietary TIA of 1-5 mg/g. The degree of destruction depends upon temperature, duration of heating, particle size and moisture conditions (Lim and Akiyama, 1992; Jansman and Poel, 1993). In general, the reduction of TIA is accompanied by a marked improvement in the nutritive value of protein source (Lim and Akiyama, 1991, Shimeno *et al.*, 1992; Rumsey *et al.*, 1993). NRC 1993 remarked that excessive heat treatment reduces the availability of heat sensitive amino acids and in particular that of lysine.

The Lectin content of the Sesame seedmeal was reduced at lower cooking and toasting time, This results agrees with the earlier work by Aregheore *et al.*, 1998 who reported a reduction in lectin content of *Jatropha* seed meal by moist heating. A reduction trend was observed in the level of anti-nutrients in the various samples with processing time. However the lectin content was completely eliminated at higher cooking and toasting time (30 minutes and 15 minutes respectively). Although Grant, 1991 reported inactivation of lectin at lower cooking time of 10 minutes which agrees with the work of Adeparusi 2001 who reported complete elimination of lectin contents of lima bean (*Phaseolus lunatus*) by dry and moist heat treatment applied. It is remarkable that lectins are usually reported as being heat-labile, their stability varies between plants species (Poel *et al.*, 1990, Almeida *et al.*, 1991).

Phytin contents of the sesame seed meal was significantly reduced with processing time. This is in agreement with the work of Hossain and Jauncey, 1990 who reported reduction of phytic acids in linseed and sesame meals by up to 72 and 74% respectively. Phytates can reduce bio-availability of minerals, impaired protein digestibility caused by formation of phytic-protein complexes and depressed absorption of nutrients due to damage to the pyloric caeca region of the intestine (Francis *et al.*, 2001).

Tannin contents of sesame seed meal also reduced with processing time. Moist heat treatment gave a higher reduction in tannin than dry heat treatment. This agrees with the report of Nyachoti *et al.*, 1997 and Adeparusi, 2001. Tannins anti-nutritional effects include interference with the digestive processes either by binding enzymes or by binding to feed components like proteins or minerals (Elkin and Roger, 1990, Hagerman *et al.*, 1992). Tannins also have the ability to complex with vitamin B₁₂ (Liener, 1980, Francis *et al.*, 2001). Tannins are also known to interact with other antinutrients; Fish and Thompson, 1991 reported the inhibitory action of tannins on amylase by interaction between tannins and Lectin. So also interaction between tannins and cyanogenic glucosides reduced the deleterious effect of the latter (Goldstein and Spencer, 1985).

Moist heat treatment reduced the saponin contents of sesame than dry heat treatment. Francis *et al.*, 2001 recommended that because of high solubility of most saponin in water,

aqueous extraction would remove most saponins from feed ingredients. The anti-nutritional effects of saponins include increased permeability of small intestinal mucosa cells thereby inhibiting nutrient transport. Other properties of saponin may also play a role in its growth depressing action. Endogenous saponins have been found to reduce protein digestibility of soybean by chymotrypsin (Shimoyamada *et al.*, 1998), probably by the formation of sparingly digestible saponin-protein complexes (Potter *et al.*, 1993). Complex formation between saponins and other antinutrients as reported by Makkar *et al.*, 1995a could lead to inactivation of the toxic effect of both the substances. This is considered to be due to chemical reactions between them, leading to the formation of tannin-saponin complexes thereby inactivating the biological activity of both tannins and saponin.

Same trend of results as above was observed with respect to oxalate contents of sesame seed meal. Narasinga Rao, 1985, Gopalan *et al.*, 1982 and Deosthale, 1981 reported the sesame seed contain oxalates which reduces the physiological availability of calcium from seeds.

CONCLUSION

Cooking and Toasting impacted some chemical changes in the nutritional composition of sesame seed meal.

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