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Biochemistry

# Effects of Processing Techniques on the Nutritional and Antinutritional Contents of Mango (*Mangifera indica*) Seed Kernel

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## ABSTRACT [ENGLISH/ANGLAIS]

The nutritive value of raw and processed Mango seed kernel (MSK) was investigated using proximate analysis, metabolizable energy and anti-nutritional factors. Nine processing methods were carried on the raw seeds. The raw seeds had values that were significantly ( $p < 0.05$ ) higher than all the processed samples considered for ash, crude fibre and crude protein. There was general reduction in the anti-nutritional factors as a result of processing. This highest reduction was observed in MSK treated with  $\text{Ca(OH)}_2$  with percentage reduction of 95.8% for tannin, 90.6% for oxalate, 76.7% for cyanogenic glycoside, 76.2% for phytate, 95.1% for flavonoid, 65.1% for alkaloid, 59.0% for saponin and 100% for trypsin inhibitors. Treatment of soaked and boiled MSK with  $\text{Ca(OH)}_2$  was found to effectively enhance the reduction of anti-nutritional factors to barest minimum.

**Keywords:** Mango seed kernel, detoxification, anti-nutritional factors, metabolizable energy

## RÉSUMÉ [FRANÇAIS/FRENCH]

La valeur nutritive des amande de la graine, bruts et transformés Mango (MSK) a été étudiée en utilisant une analyse immédiate, de l'énergie métabolisable et facteurs anti-nutritionnels. Neuf méthodes de traitement ont été effectués sur les graines crues. Les graines crues avaient des valeurs qui étaient significativement ( $p < 0,05$ ) plus élevé que tous les échantillons traités considérés comme des cendres, en cellulose brute et des protéines brutes. Il y avait la réduction générale dans les facteurs anti-nutritionnels comme un résultat du traitement. Cette réduction la plus forte a été observée dans MSK traitées avec  $\text{Ca(OH)}_2$  avec réduction en pourcentage de 95,8% pour le tannin, 90,6% pour l'oxalate, 76,7% pour les glycoside cyanogène, 76,2% pour les phytates, 95,1% pour les flavonoïdes, 65,1% pour les alcaloïdes, 59,0 % de saponine et 100% pour les inhibiteurs de trypsine. Traitement de MSK trempées et bouillies avec du  $\text{Ca(OH)}_2$  a été trouvé à améliorer efficacement la réduction des facteurs anti-nutritionnels à plus strict minimum.

**Mots-clés:** Amande de la graine de mangue, de désintoxication, facteurs anti-nutritionnels, de l'énergie métabolisable

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Accepted/Accepté: May, 2012

Full Citation: Dakare MA, Ameh DA, Agbaji AS, Atawodi SE. Effects of Processing Techniques on the Nutritional and Antinutritional Contents of Mango (*Mangifera indica*) Seed Kernel. World Journal of Young Researchers 2012;2(3):55-9.

## INTRODUCTION

Mango (*Mangifera indica*) belongs to the fruits family Anacardiaceae [1]. Mango seed kernels (MSK) contained carbohydrate (69.2 - 80%), protein (7.5 - 13%), fibre (2.0 - 4.6%), ash (2.2 - 2.6%), calcium (0.21%) and phosphorus (0.22%), which is comparable to that of maize, depending on the variety [2 - 5]. The kernel is also balanced in amino acids [6].

There are few reports on the use of MSK in livestock feeding, but the level of inclusion in poultry diets has been low because of the presence of high tannin content which reduces chick growth [7, 8].

Joseph and Abolaji [9], Diarra and Usman [10] and others reported the use of boiling to detoxify MSK but with

poor result. It has been observed that boiling can reduce 33 - 55% of tannins in seeds [11, 12].

The objective of this study is to developing an appropriate processing method that will further reduce the toxic substances limiting the utilization of MSK in poultry diet.

## MATERIALS AND METHODS

### Collection and processing of mango seed kernels:

Mango seeds were collected during the month of May (peak of the mango season) in Basawa Zaria, Kaduna state, Nigeria. The kernel was removed by manual cracking and sun-dried. The dried kernel was crushed into pebbles (reduced particle sizes) and then different

processing methods were carried out according to Patil, et al, [13] with modification as follows:

*Method A:* Raw mango seed kernel (R-MSK) pebbles were soaked with four times its volume of water and allowed to stand for 24 hours at room temperature with occasional stirring. The supernatant was decanted and the residue washed several times (until it's water was clear), sun-dried and labelled S-MSK.

*Method B:* R-MSK was boiled in water at 100°C for 30 minutes and allowed to cool overnight. The supernatant was decanted and the residue washed as in method A, sun-dried and labelled B-MSK.

*Method C:* A fresh sample of R-MSK pebbles were soaked with four times its volume of 0.3M HCl solution and allowed to stand for 24 hours at room temperature with occasional stirring. The supernatant was decanted and the residue washed as in method A, sun-dried and labelled SH-MSK.

*Method D:* A fresh sample of R-MSK pebbles were suspended in water and to the mixture, 1g Ca(OH)<sub>2</sub>/L/Kg R-MSK was added, stirred thoroughly and kept overnight. The supernatant was decanted and the residue washed as in method A, sun-dried and labelled SC-MSK.

*Method E:* Part of the processed residue from method B (B-MSK) was taken and soaked with four times its volume of 0.3M HCl solution and allowed to stand for 24 hours at room temperature with occasional stirring. The supernatant was decanted and the residue washed as in method A, sun-dried and labelled BH-MSK.

*Method F:* Another part of the processed residue from method B (B-MSK) was taken and suspended in water and to the mixture, 1g Ca(OH)<sub>2</sub>/L/Kg B-MSK was added, stirred thoroughly and kept overnight. The supernatant was decanted and the residue washed as in method A, as in method A, sun-dried and labelled BC-MSK.

*Method G:* A fresh sample of R-MSK was processed as in method A and the residue obtained was also processed as in method B. This was labelled SB-MSK.

*Method H:* Part of the processed residue from method G (SB-MSK) was taken and soaked with four times its volume of 0.3M HCl solution and allowed to stand for 24 hours at room temperature with occasional stirring. The supernatant was decanted and the residue washed as in method A, sun-dried and labelled SBH-MSK.

*Method I:* Another part of the processed residue from method G (SB-MSK) was taken and suspended in water and to the mixture, 1g Ca(OH)<sub>2</sub>/L/Kg SB-MSK was added, stirred thoroughly and kept overnight. The supernatant was decanted and the residue washed as in method A, sun-dried and labelled SBC-MSK.

A sample each of the raw (R-MSK) and processed MSK (S-MSK, B-MSK, SH-MSK, SC-MSK, SB-MSK, SBH-MSK and SBC-MSK) was grounded and analyzed for proximate composition and antinutritional factors each in three replicates.

## Chemical Analysis

### a. Proximate analysis

Moisture, ash, and crude lipid were determined according to AOAC [14]; crude protein by Onyeike, and Osuji, [15]; crude fibre was determined according to NIS [16] and carbohydrate was calculated by difference. The metabolizable energy (ME) content was calculated according to Diarra et al, [5] as ME (kcal/kg) = 432 + 27.91 (CP + NFE + 2.25 × EE).

### b. Antinutritional factors:

Tannin [17], Saponin [14], Oxalate [18], Cyanogenic glycoside [19], Phytate [20], Alkaloid [21], Flavonoid [22] and Trypsin inhibitor [23] were determined on the raw and processed MSK.

## RESULTS AND DISCUSSION

The proximate composition and the metabolizable energy of both raw and processed mango seed kernel are shown in table 1. The values of processed crude protein is significantly ( $p < 0.05$ ) lowered than that of the raw. The decrease in crude protein values as a result of soaking and boiling is in line with the observation of earlier report by Akinmutimi and Onwukwe [24]. This has been attributed to the leaching of nutrients due to boiling. The ash and crude fibre contents obtained for the raw MSK was higher than that obtained for the processed MSK. This is in agreement with the report of Akinmutimi [25]. The nitrogen free extract (NFE) of the processed MSK is higher than the raw MSK but still within the range of value reported for maize used for poultry diet [26]. The presences of anti-nutritional factors present in both raw and processed in MSK are showed in table 2. The processed MSK showed very promising results as tannins, trypsin inhibitor and oxalate were almost completely removed while cyanogenic glycoside was lowered to about 3.4mg/100g (76% reduction) which is considered acceptable for a feedstuff [1].

The reduction in oxalate shows the thermostability of oxalate. Phytate followed similar trend like that of oxalate. There was general reduction in the content on anti-nutritional factors as a result of processing. The highest reduction was observed in MSK treated with Ca(OH)<sub>2</sub> with percentage reduction of 95.8% for tannin,

90.6% for oxalate, 76.7% for cyanogenic glycoside, 76.2% for phytate, 95.1% for flavonoid, 65.1% for alkaloid, 59.0% for saponin and 100% for trypsin inhibitors. The 100% reduction in trypsin inhibitor confirms the report of

earlier reports that heat treatment completely destroys trypsin inhibitors [27,28]. This implies that problem of pancreatic hypertrophy due to trypsin inhibitors cannot exist in processed MSK.

**Table 1:** This table shows proximate composition of raw and processed Mango seed kernel (% DM Basis)

Parameters	R-MSK	S-MSK	B-MSK	SH-MSK	SC-MSK	BH-MSK	BC-MSK	SB-MSK	SBH-MSK	SBC-MSK	SEM
Moisture (%)	6.52 ± 0.07	5.79 ± 0.21	6.13 ± 0.15	7.01 ± 0.03	6.63 ± 0.12	7.00 ± 0.09	8.37 ± 0.12	6.14 ± 0.03	7.81 ± 0.05	8.33 ± 0.05	0.873
Ash (%)	2.19 ± 0.16	1.67 ± 0.24	1.07 ± 0.09	1.11 ± 0.10	1.57 ± 0.07	1.19 ± 0.22	1.93 ± 0.26	1.67 ± 0.24	0.94 ± 0.10	1.96 ± 0.05	0.409
Crude Protein (CP) (%)	7.40 ± 0.31	6.03 ± 0.02	6.36 ± 0.03	6.37 ± 0.09	6.17 ± 0.17	6.79 ± 0.21	6.33 ± 0.12	6.83 ± 0.05	6.51 ± 0.03	6.83 ± 0.13	0.428
Ether Extracts (EE) (%)	10.90 ± 0.29	13.04 ± 0.20	10.75 ± 0.19	11.49 ± 0.41	12.00 ± 0.09	10.80 ± 0.22	9.59 ± 0.15	10.70 ± 0.14	10.47 ± 0.05	8.50 ± 0.08	0.341
Crude fibre (CF)(%)	2.82 ± 0.14	2.47 ± 0.05	1.99 ± 0.01	2.17 ± 0.12	2.48 ± 0.02	1.40 ± 0.08	2.10 ± 0.08	1.94 ± 0.10	1.51 ± 0.40	2.50 ± 0.02	0.427
Nitrogen Free extracts (NFE)% Metabolizable	69.93 ± 0.80	70.98 ± 0.28	73.69 ± 0.09	71.85 ± 0.71	71.15 ± 0.34	72.81 ± 0.64	71.68 ± 0.54	72.73 ± 0.40	72.76 ± 0.31	71.88 ± 0.10	0.788
Energy (ME) (Kcal/K g)	3,275	3,400	3,341	3,337	3,344	3,332	3,312	3,324	3,302	3,163	

Values are mean ± standard error of mean for three replicates

## CONCLUSION

The results of chemical analysis showed no adverse effect of soaking, boiling, HCl treatment and Ca(OH)<sub>2</sub> treatment on the crude protein, ether extract and nitrogen free extract. Treatment of soaked and boiled MSK with Ca(OH)<sub>2</sub> was found to effectively enhance the reduction of anti-nutritional factors to barest minimum, if not complete removal. This implies that this processing method had greatly detoxified the MSK, thereby enhancing better utilization of the MSK in livestock and poultry nutrition.

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**Table 2:** This table shows proximate composition of raw and processed Mango seed kernel (% DM Basis)

Parameters	R-MSK	S-MSK	B-MSK	SH-MSK	SC-MSK	BH-MSK	BC-MSK	SB-MSK	SBH-MSK	SBC-MSK
Tannin (%)	0.409 ± 0.02	0.212 ± 0.13	0.118 ± 0.07	0.120 ± 0.11	0.115 ± 0.22	0.112 ± 0.01	0.104 ± 0.06	0.081 ± 0.05	0.065 ± 0.15	0.017 ± 0.02
% Tannin reduction	-	48.2	61.1	55.7	65.9	72.6	74.6	80.2	77.1	95.8
Saponin (%)	10.5 ± 0.14	9.8 ± 0.25	8.1 ± 0.33	9.4 ± 0.17	9.0 ± 0.35	8.0 ± 0.01	7.9 ± 0.04	6.5 ± 0.05	5.3 ± 0.15	4.3 ± 0.43
% Saponin reduction	-	6.7	22.9	10.5	14.3	23.8	24.8	38.1	49.5	59.0
Oxalate (mg/100g)	1192.5 ± 0.22	922.5 ± 0.35	225.0 ± 0.03	431.5 ± 0.07	312.0 ± 0.08	182.5 ± 0.18	148.1 ± 0.31	122.5 ± 0.45	202.0 ± 0.45	112.5 ± 0.06
% Oxalate reduction	-	22.6	81.1	63.8	73.8	84.7	87.6	89.7	83.1	90.6
Phytate (mg/100)	487.3 ± 0.51	371.3 ± 0.32	278.5 ± 0.26	280.1 ± 0.19	274.1 ± 0.11	171.2 ± 0.06	139.2 ± 0.44	232.1 ± 0.65	162.4 ± 0.06	116.0 ± 0.05
% Phytate reduction	-	23.8	42.8	42.5	43.8	64.9	71.4	52.4	66.7	76.2
Cyanogenic glycoside (HCN) (mg/100g)	14.1 ± 0.15	11.4 ± 0.23	8.8 ± 0.43	9.0 ± 0.55	8.5 ± 0.37	7.2 ± 0.48	6.4 ± 0.36	6.0 ± 0.45	11.7 ± 0.24	3.4 ± 0.63
% Cyanogenic glycoside reduction	-	19.1	37.6	35.8	39.5	48.7	54.8	57.1	17.0	76.2
Alkaloid (%)	6.3 ± 0.20	5.6 ± 0.17	3.1 ± 0.04	4.5 ± 0.09	4.6 ± 0.12	3.6 ± 0.06	3.0 ± 0.05	2.3 ± 0.08	2.4 ± 0.15	2.2 ± 0.01
% Alkaloid reduction	-	11.1	50.8	28.6	27.0	42.9	52.4	63.5	61.9	65.1
Flavonoid (%)	12.2 ± 0.18	10.2 ± 0.07	9.4 ± 0.17	7.1 ± 0.08	8.2 ± 0.21	6.3 ± 0.16	5.2 ± 0.05	5.8 ± 0.15	4.3 ± 0.10	0.6 ± 0.13
% Flavonoid reduction	-	16.4	23.0	41.8	32.8	48.4	57.4	52.5	64.8	95.1
Trypsin inhibitor (mg/g)	27.5 ± 0.09	18.2 ± 0.06	0.5 ± 0.10	10.1 ± 0.11	0.3 ± 0.02	0.1 ± 0.01	0.0 ± 0.00	0.0 ± 0.00	0.0 ± 0.00	0.0 ± 0.00
% Trypsin Inh. Reduction	-	33.8	98.2	63.3	98.9	99.6	100	100	100	100

Values are mean ± standard error of mean for three replicates

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**ACKNOWLEDGEMENT / SOURCE OF SUPPORT**

Nil

**CONFLICT OF INTEREST**

No conflict of interests was declared by authors.

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