Original Article

Biochemistry

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

Monday A DAKARE [1*], Danladi A AMEH [2], Abel S AGBAJI [1], Sunday E ATAWODI [2]

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 $Ca(OH)_2$ 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 $Ca(OH)_2$ 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 $Ca(OH)_2$ avec réduction en pourcentage de 95,8% pour le tanin, 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 $Ca(OH)_2$ 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

Affiliations:

[1] National Research Institute for Chemical Technology (NARICT), P.M.B. 1052, Zaria. NIGERIA

[2] Department of Biochemistry, Ahmadu Bello University, Zaria. NIGERIA

Email Address for Correspondence/ Adresse de courriel pour la correspondance: dakarema@yahoo.com

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):78-82.

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 $Ca(OH)_2$/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 $Ca(OH)_2$/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 $Ca(OH)_2$/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 $Ca(OH)_2$ 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. 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)%	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
Metabolizable 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 $Ca(OH)_2$ treatment on the crude protein, ether extract and nitrogen free extract. Treatment of soaked and boiled MSK with $Ca(OH)_2$ 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.

REFERENCES

[1] El Boushy ARY, Vander Poel AFB. Handbook of poultry feed from waste. Processing and use. 2nd edition. Kluwer Academic publishers; New York. 2000.

[2] Kiftewahid B, Potts GR, Drysdale RM. By-products utilization for animal production. Proceeding of a workshop on applied research held in Nairobi, Kenya, 26-30 September. Published by Inter¬national Development Research Centre, Queen Street, Ottawa, Canada. 1982. p.76.

[3] Ravindran V, Rajaguru ASB. Nutrient contents of some unconventional poultry feed J. Anim. Science. 1985;55:58-61.

[4] Arogba SS. Nigerian Mango kernel, (*Mangifera indica*): I: Physico-chemical analysis and effect of pro¬longed dry heating. In 13th NIFEST Annual Conference, University of Ibadan, Ibadan, Nigeria. 1989.

[5] Diarra SS, Usman BA, Igwebuike JU. Replacement value of boiled Mango kernel meal for maize in broiler finisher diets. ARPN Journal of Agricultural and Biological Science 2010;5(1):47–52.

[6] Anon. The Mango Grading, Storage and Marketing. A Handbook Indian Council Of Agric. Res. New-Delhi. 1967.

[7] Odunsi AA. Response of Laying Hens and Growing Broilers to the Dietary Inclusion of Mango (*Mangifera indica L.*) Seed Kernel Meal. Tropical Animal Health and production 2005;37(2): 139-50.

[8] Teguia A. Substituting ground mango kernel s (*Mangifera indica L.*) for maize in broiler starter diets. Animal Feed Science Technology1995;56:155-8.

[9] Joseph JK, Abolaji J. Effects of replacing maize with graded levels of cooked Nigerian mango-seed kernels (*Mangifera indica*) on the performance carcass yield and meat quality of broiler chickens. Bioresource Technology 1997;61:99-102.

[10] Diarra SS, Usman BA. Growth performance and some blood parameters of broiler chickens fed raw or cooked mango kernel meal. International Journal of Poultry Science 2008;7(4):315-8.

[11] Mbajunwa OK. Effect of processing on some antinutritive and toxic components of the African oil bean seed (*Pentaclethra macrophylla Benth*). Journal of Food Science and Agriculture 1995;68:153-8.

[12] Akinmutimi AH. Nutritive value of raw and processed Jack Fruit Seeds (Artocarpus heterophyllus): Chemical Analysis. Agricultural Journal 2006;1(4):266-71.

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

[13] Patil SN, Netke SP, Dabadghoo AK. Processing and feeding value of mango seed kernel for starting chicks. Br. Poultry science 1982;23:185-94.

[14] AOAC. Standard Official Methods of Analysis of the Association of Official Analytical Chemists. 14 Edn., Williams, SW. (Bd.), Washington DC. 1984.

[15] Onyeike EN, Osuji JO. Research techniques in biological and chemical sciences. Springfield publishers Ltd. Owerri. 2003.
[16] NIS. Nigeria Industrial Standard of Standard Organisation of Nigeria (NIS-SON) on Test Method for Corn Starch (Food grade).2008.
[17] Makkar HPS, Blummel M, Borowy NK, Becker K. Gravimetric of tannins and their correlations with chemical and protein precipitation methods. J.Sci. Food Agric. 1993;61:161-5.
[18] Oke OL. Chemical studies on some Nigerian foodstuffs. Latum. W. Afric J. Biol. and Appl. Chem. 1969;8:53-6.
[19] Onwuka GI. Food Analysis and Instrumentation (Theory and practice). Naphthali prints. Surulere, Lagos. 2005.
[20] Lucas GM, Markakas P. Phytic acid and other phosphorus compounds of bean (*Phaseolus vulgaris*) J. Agric. Ed Chem.1975;23:13-5.
[21] Harbone JB. Phytochemical methods. Chapman and Hall. New York. 1980.
[22] Bohm BA, Kocipai-Abyazan R. Flavonoids and condensed tannins from leaves of Hawaiian vaccinium vaticulatum and V. calycinium. Pacific Sci. Burkill HM 1974;48:458-63.
[23] Kakade ML, Simon N, Liener IE. An evaluation of natural versus synthetic substrates for measuring the antitryptic activity of soyabean samples. Cereal chemistry 1969;46:518
[24] Akinmutimi AH, Onwukwe CC. Effect of cooking with various concentrated potash on nutrient composition of lima beans. J. Agric. Biotech. Environ.2002;1:1-3.
[25] Akinmutimi AH. Effect of cooking on nutrient composition of mucuna utilis seeds; Nigeria Poultry Sci. J.2001;3:45–51.
[26] Kadashi YD. Vitamins and Minerals Nutritional Foods in Nigeria. De-peak publishers. Zaria, Kaduna state;2005.
[27] Akanji AM, Ologbobo AD, Emiola IA, Adedeji OS. Effect of various processing on Heamagluttinin and other anti-nutritional factors in Jack Bean, NSAP proceeding, IARST, Ibadan;2003.P.189–93.
[28] Liener IE. Toxic constituents of plant food stuffs. Academic press. Inc New York;1980.p.8-13.

ACKNOWLEDGEMENT / SOURCE OF SUPPORT

Nil

CONFLICT OF INTEREST

No conflict of interests was declared by authors.