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Physico-chemical and anti-nutritional characterization of the kernels of some mango (*Mangifera indica*) cultivars grown in Western parts of Nigeria

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Abstract
Ten mango (*Mangifera indica*) cultivars grown in western parts of Nigeria were identified as Alphonso, Indesina, Julie, Kent, Mabranka, Magadugu, Peach, Peter, Taymour, and Oori. The percentage weight ratio (PWR) of kernel to fruit, seed to fruit and kernel to seed of the mangoes ranged between 2.38 – 10.79%, 6.36 – 17.21% and 36.22 – 63.35% respectively. The PWR of kernel to fruit (10.79%), seed to fruit (17.21%) and kernel to seed (63.35%) of "Oori" cultivar were significantly higher ($p < 0.05$) than other cultivars, except the values of PWR of kernel to seed of Indesina (60.05%) and Kent (62.72%). Values of Julie cultivar on the parameters measured were significantly lower ($p < 0.05$) than others. The range of nutrients of the kernels were protein (6.24 – 8.19%), fat (5.92 – 13.50%), fibre (2.22 – 3.95%), ash (0.52 – 3.54%) and carbohydrate (75.02 – 83.04%). The protein of Julie (7.88%), Indesina (8.05%) and Oori (8.19%) and fat of Mabranka (13.10%) and Alphonso (13.50%) were significantly higher ($p< 0.05$) than other cultivars. The carbohydrates in the mango kernels was high; although values recorded for Mabranka (75.02%) and Alphonso (75.09%) were significantly lower ($p< 0.05$) than other cultivars. The pH of fresh mango kernels ranged between 4.10 and 5.80, while titratable acidity was between 9.92 – 64.35mg/100g. The anti-nutrients in the mango kernels were tannin, flavonoid, phenolic compound, oxalate and phytate. Tannin (37.30 – 163.33g/kg), phytate (0.442 – 0.897mol/kg) and oxalate (18.74 – 54.24mg/100g) were significantly different ($p< 0.05$) among the mango cultivars. Tannin and oxalate contents of Oori (157.33; 54.24g/kg), Alphonso (163.33; 49.55g/kg) and Phytate content of Mabranka (0.442mol/kg), Alphonso (0.453mol/kg) and Indesina (0.478mol/kg) respectively were significantly higher ($p< 0.05$) compared with other cultivars.
Key words: Mango cultivars, percentage weight ratio, nutrients, anti-nutrients,

Introduction

Many cultivars of mango exist, the Indian groups are the best known around the world and of these Alphonso, Peter and Julie are very good yielder of fine flavour. Many local cultivars found in Kwara and Oyo states of Nigeria suffer from a distinct taste of turpentine, but this is completely absent in the varieties earlier mentioned.
Mango seed (40-50% of total fruit weight) is wasted during processing in many parts of the world. In Nigeria, the seeds are thrown away after been eating constituting waste and environmental pollution. The kernel contains various nutrients such as high level of carbohydrates (starch), fats and some protein among others (INPhO, 2005).
Joseph and Abolaji (1997) reported that tannin was the predominant anti-nutrient in Nigerian wild mango kernels. It has become imperative to harness unconventional feedstuff resources through a careful identification, chemical and feeding trial evaluation of the indigenous plant species and their fruits which constitutes waste around us for sustainable livestock production. Exploiting cheap feed sources for animal production would lower the market price and therefore, the intake of animal protein by the general populace in under developed countries, such as Nigeria. This would in turn, ameliorate the havoc caused by malnutrition and under-nutrition in such societies, the brunt of which is borne by children and women. The objective of this study is to evaluate the physical characteristics, chemical and anti-nutritional constituents of the kernels of ten mango cultivars with a view to determining their nutritive potentials in poultry diets.

Materials and Methods

Identification of mango (*Mangifera indica*) kernel cultivars

The mango (*Mangifera indica*) cultivars were identified with the assistant of the staff' of Nursery Department, Kwara State Ministry of Agriculture and Natural Resources (MANR) Ilorin, Nigeria.

Sample collection for measurements and laboratory analysis

Matured fresh fruit samples of the mango cultivars were obtained from the Nursery Department, Kwara State Ministry of Agriculture and Natural Resources (MANR) Ilorin. The "Oori" cultivar's locally known as "Ogbomoso mango" was obtained from some mango plantations in Ogbomoso town, Oyo state, Nigeria. The mango fruits were cleaned labeled and packed into plastic containers before taken to the laboratory for further analysis.

Physical characterization of the mango fruits

Physical analysis was carried out on fruits of the identified mango (*Mangifera indica*) cultivars in order to determine the quantity of kernels recovery after harvest and processing in relation to the total mango fruits.

Functional properties:

Fruits weight and kernels dimension

Fruit (seeds and kernels) weight was taken on a citizen (model MP-300) electronic balance. While, the length and breadth of each kernel was determined using tape rule.

Estimation of fresh mango kernel volume and specific gravity

The platform scale method described by Mohsenin (1986) was used. Fresh kernel was weighed on the electronic balance (Weight of kernel in air). Distilled water at 27 ± 1^0C was poured into clean 250ml capacity measuring cylinder to the 100ml mark.

The volume and weight of water displaced when the kernel is submerged was noted.

Volume of fresh kernel: $\frac{\text{Weight of displaced water}}{\text{Density of water}}$

Specific gravity: $\frac{\text{Weight of kernel in air x Specific gravity of water}}{\text{Weight of displaced water}}$

Determination of pH of the fresh mango kernels

Five grammes of fresh mango kernel was mashed into a 100ml beaker, 45ml of distilled water (pH 7.0) was added and allowed to stand for 30mins while stirring occasionally with a glass rod. The pH was measure with a Crison micro pH meter (Model 2000) after allowing the suspension to stand still.

Determination of titratable acidity of fresh mango kernels

The method of AOAC (2000) was used. Zero point zero one molar (0.01M) NaOH was titrated against 10ml of the filtrate using phenolphthalein indicator. The end point was indicated by a change in colour of the sample to pink. The amount of acid in milligramme per hundred grammes (mg /100g) was calculated as stated below.

$$\text{Titratable acidity} = \frac{0.01 \times 0.220 \times T \times 10 \times 1000}{Ft \times S}$$

Where 0.01M = molarity of NaOH used

0.220 = conversion factor for phytic acid, since it is present in mango
T = titre value
Ft = quantity of filtrate used
S = quantity of sample weighed
10 = dilution factor
1000 = conversion to mg/100g (Krishna and Ranjhan, 1982)

Determination of mango kernels bulk density

A 100ml capacity measuring cylinder was filled with distilled water up to the 60ml mark. 20g of dry mango kernel meal was weighed into the cylinder before it was tapped 10times against the palm and placed on the table until an equilibrium volume was reached. The final volume of the water was taken and then used to calculate the bulk density (Okaka and Potter, 1979; NSTF, 2004).

Calculation: Bulk density (g/ml) = $\frac{\text{Mass of sample}}{Fvw - Ivw}$

Ivw = Initial volume of distilled water
Fvw = Final volume of distilled water after tapping

Proximate analysis:

Determination of dry matter content of mango kernels

Two- grammes of fresh mango kernel were weighed into a clean boat of predetermined weight. The sample was dried to a constant weight in an oven at 100^oC for 24hours. The porcelain boat was placed in the dessicator and

allowed to cool for 1 hour before it was reweighed. Dry matter was calculated and expressed as percentage. (Cullison, 1982; AOAC, 2000).

$$\text{Dry matter (\%)} = \frac{\text{Weight left after drying}}{\text{Initial Weight of sample}} \times \frac{100}{1}$$

Determination of total ash in mango kernels

The standard method described in AOAC (2000) was used. 2g of dry ground sample was weighed into a clean crucible of predetermined weight. The weight of the sample and crucible were recorded respectively. The sample was burnt in the muffle furnace at 600^{o}C for 3 hours. The crucible was removed with tung and allowed to cool in a dessicator for 2 hours before it was reweighed, the percentage ash was calculated using he formular.

$$\text{Total ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times \frac{100}{1}$$

Estimation of crude protein in mango kernels

Kjeldahl method described in AOAC (2000) was used. 2g of dry mango kernel was weighed into a Kjeldahl flask, 10g of sodium sulphate (to raise the boiling point) and 0.5g cupper sulphate was added as catalyst; then, 25ml of conc. Sulphuric acid was added. This was digested by burning on a heating mantle until a clear solution was obtained (when oxidation was completed) the digestion converted all the organic nitrogen to ammonia which is trapped as ammonium sulphate. The emerging clear solution was allowed to cool and distilled water was added to it and rinsed into 250ml volumetric flask and was make-up to mark. 5ml of diluted solution was introduced into a semi-automatic Buchi distillation unit (Model K-350). The ammonia was released by the auto-addition of 5ml of 40% sodium hydroxide (or excess). The mixture was steam distillated for 3munites when about 65ml of the distillate was collected into 5ml boric acid – methyl red – methylene blue indicator and then titrated with 0.01M hydrochloric acid.

The amount of 0.01M HCl used to regenerate the original blue colour of the indicator from the green was recorded as the titre value. The nitrogen content of protein is generally assumed to be 16% by weight. The percentage nitrogen content of each sample was calculated as shown below. This was multiplied by a conversion factor of 6.25 to obtain the percentage crude protein.

$$\%\ N = 0.01 \times 0.014 \times T \times \frac{250}{5} \times \frac{100}{W}$$

Where, T = titre value
W = Weight of sample used.

Determination of crude fat in mango kernels

Soxhlet extraction method described in AOAC (2000) was adopted. 2g of dry mango kernel cake was weighed into a previously prepared extraction thimble. The mouth of the thimble was plugged with fat free absorbent cotton wool. The receiver flask of the soxhlet was clean, dried and weighed accurately before the thimble with sample was introduced into the soxhlet extractor. The apparatus was assembled and filled with petroleum spirit to half capacity of the volume of the flask before the fat of the sample was extracted for 4 hours.

$$\text{Calculation: Crude fat (\%)} = \frac{WF - W}{S} \times \frac{100}{1}$$

Where, WF = weight of the receiver flask and fat deposits
W = weight of empty receiver flask only.
S = Weight of sample used.

Determination of crude fibre in mango kernels

This was performed according to the method described in Cullison (1982) and AOAC (2000). Two grammes of dry sample was defatted using soxhlet extractor. The fat free sample was transferred into a one litre (1 litre) beaker. Boiling water was added with 25ml of 2.5M H_2S0_4 is mixed and the volume is made up to 200ml level. This was boiled for 30 min. filtered by means of suction, through the butchner filter. The residue was washed twice with boiling water and transferred into the beaker, and then 25ml of 2.5M NaOH was added to it and diluted to the 200ml mark. The beaker was heated and boiled for 30mins and another filtering procedure was repeated. The resulting residue was quantitatively transferred to a porcelain crucible. Finally, the fibre cake was

extracted and dried by moisturizing with small portion of ethanol; which is permitted to drain between additions. Crucible was dried along with the materials at 100^0C to a constant weight, cool and weighed. The content of the crucible was incinerated at 600^0C for 3hrs in a muffle furnace until all the carbonaceous matters was burnt. The crucible containing the ash was cooled in the desiccator and weighed.
Calculation:

$$\text{Crude fibre (\%)} = \frac{100 - \{W_1 - W_2\}}{W}$$

Where, W_1 = weight in gramme of porcelain crucible and content before ashing
W_2 = weight in gramme of porcelain crucible containing ash
W = weight of sample in gramme

Determination of anti-nutrients:
Qualitative analysis of anti-nutrients in the kernels
The anti-nutrients screening of mango kernel was carried out following the methods described by Odebiyi and Sofowora (1978); Trease and Evans (1989).

Estimation of total soluble tannins in mango kernels
Copper acetate gravimetric method described by Joslyn (1970) was used to determine the total soluble tannins in the kernels of the identified mango cultivars. Five grammes of dry mango kernel was boiled with 50ml of distilled water in a 250ml conical flask for 20min. This was filtered with Whatman No 1 filter paper, then the filtrate was recovered into 250ml beaker and the residue discarded. 10ml of 4.0% copper acetate solution was added to the hot filtrate and boiled for 10 minutes. The precipitate was filtered and the filtrate was discarded. The residue was dried with the filter paper. The dried sample was scrapped from the filter paper into a pre-weighed crucible. The weight was recorded (W) and was incinerated in a muffle furnace at 600^0C. It was cooled in a dessicator and then re-weighed (W_1). The difference between the weight of sample before ashing and the ash residue after incineration represents the total soluble tannin.
Calculation:

$$\text{Total soluble tannin (\%)} = \frac{\text{Weight loss after ashing}}{\text{Weight of sample}} \times \frac{100}{1}$$

Determination of phytate in mango kernels
Phytate was quantitatively determined according to the method described by wheeler and Ferrel (1971). 4g of ground mango kernel was soaked in 100ml of 2% HCl for 3hours and then filtered through Whatman No 1 filter paper. 25ml of the filtrate was placed in a 100ml conical flask and 5ml of 0.3% ammonium thiocyanate solution was added as indicator. Then, 53.5ml of distilled water was added to the mixture to give it proper acidity; this was titrated with a standards iron III chloride solution, which contains about 0.00195g of iron per milliliter, until a brownish – yellow colour appeared which persists for 5 minutes.
Calculation:

$$\text{Phytate content (mol/kg)} = \frac{T \times 564.11}{M}$$

Where T = titre value; M = Molar mass of phytate

Determination of Oxalate in the kernels

Oxalate was determined using the modified method employed by Ukpabi and Ejidoh (1989). The procedure involves the digestion of sample containing oxalate, precipitation of the oxalate to remove ferrous ions on addition of NH_40H solution and permanganate titration of the total filtrate resulting from digestion and oxalate precipitation.

Digestion:

Two-grammes of ground mango kernel were suspended in 190ml of distilled water contained in a 250ml volumetric flask and boiled for 1 hour. 10ml of 6M HCl was added before digestion at 100^oC. The suspension was cooled and made-up to 250ml mark of the flask and then filtered.

Oxalate Precipitation:

Duplicate portion (125ml) of the filtered mango kernel digest was placed in two different 250ml beaker, followed by the addition of conc. NH_40H solution (drop-wise) until the test solution changes from its salmon

pink colour to a faint yellow colour. Each portion was heated to 90°C, cooled and filtered with Whatman No.1 filter paper to remove brownish precipitate containing ferrous ions. The golden yellow filtrate was heated to 90°C and 10ml of 5% calcium chloride solution was added while being stirred constantly. The solution was cooled and left overnight at 5°C thereafter the solution was centrifuged at 2500rpm for 5min. The supernatant was decanted and the precipitate, completely dissolved in 20cm^3 of 20% v/v H_2SO_4 solution.

Permanganate Titration:

The total filtrate resulting from the digestion and oxalate precipitation, which dissolved, in 20ml of 20% v/v H_2S0_4 solution was titrated against 0.05M $KMnO_4$ solution to a faint pink colour which persisted for 30secs.

Calculation: Oxalate content (mg/100g) = $\frac{T \times [Vme] [DF] \times 2.4 \times 10^2}{ME \times Mf}$

Where: T = titre value of $KMnO_4$

Vme = Volume-mass equivalent (i.e 1ml of 0.05M $KMn0_4$ solution is equivalent to 0.00225g anhydrous oxalic acid)

DF = Dilution factor, VT/A

VT = Total volume of filtrate (300ml)

A = Aliquot used (125ml)

ME = molar equivalent of $KMnO_4$

Mf = Weight of sample use

Results and Discussion

Ten (10) Mango cultivars were identified as Alphonso, Indesina, Julie, Kent, Mabranka, Magadugu, Peach, Peter, Taymour and Oori (A Nigeria local mango cultivar commonly referred to as "Ogbomoso mango"). The percentage weight ratio of kernel to fruit, seed to fruit and kernel to seed weights of the mango cultivars ranged between 2.38 – 10.79%, 6.36 – 17.21% and 36.22 – 63.35% respectively. The range of values recorded for other parameters that were measured on the kernels were bulk density (1.056 – 1.159g/cm^3), volume (7.69 – 28.22cm^3) and dimension (42 x 21 x 9 – 75 x 43 x 16mm) (Table 1). The percentage ratio of kernel to fruit weight (10.79%), seed to fruit weight (17.21%) and kernel to seed weight (63.35%) of the "Oori" cultivar were significantly higher ($p < 0.05$) than other mango cultivars that were investigated, except the values obtained for the percentage ratio of kernel to seed weight of the Indesina (60.05%) and Kent (62.72%) cultivars. The values obtained for Julie cultivar on all the parameters measured were significantly lower ($p < 0.05$) than the other mango cultivars that were examined (Table 1). Results of this investigation showed considerable variations in the physical characteristics, nutritional and anti-nutritional factors depending on the variety of mango. Most of the average results obtained for the physical characteristics, nutritional and anti-nutritional factors are comparable to the result obtained on the kernel of local mango cultivars from Culiacan, Mexico (Zazueta – Murales, 2006). Most of the kernel to the fruit weight ratio is about 10% and the kernel to the seed weight ratio of the mango cultivars were generally lower than 75% reported by INPhO, 2005. The "Oori" cultivar's which had the highest seed to the fruit weight ratio, kernel to the fruit weight ratio and the dry matter recovery of the kernels (Table 1), stand a better chance to be used as a supplement for maize in poultry diets; although this mango cultivar seems to contain high level of anti-nutrients (Table 4).

The range of pH obtained for the fresh kernels of the mangoes was between 4.10 and 5.80; while, the titratable acidity was between 9.92 – 64.35mg/100g (Table 2).

Results of nutrient composition of the mango kernels are shown in Table 2. The dry matter content of the kernels ranged between 32.67 – 56.49%, values obtained for the Peter (32.67%) and Julie (35.43%) cultivars were significantly lower ($p< 0.05$) than the values of other cultivars. The range of values obtained for the nutrients of the mango kernels are crude protein (6.24 – 8.19%), crude fat (5.92 – 13.50%), crude fibre (2.22 – 3.95%), total ash (0.52 – 3.54%) and total carbohydrate (75.02 – 83.04%). The crude protein content of the Julie (7.88%), Indesina (8.05%) and Oori (8.19%) cultivars and the crude fat content of the Mabranka (13.10%) and Alphonso (13.50%) were significantly higher ($p< 0.05$) than the values of other cultivars. The values of total carbohydrates in all the mango kernels was generally high; although the values recorded for the Mabranka (75.02%) and Alphonso (75.09%) were significantly lower ($p< 0.05$) than the values obtained for other mango cultivars.

The anti-nutrients content of fresh mango kernels of the cultivars tested are shown in Table 3. They include tannins, flavonoids, phenolic compound, oxalates, phytates and traces of hydrocyanic acid. These anti-nutrients were detected in all the mango cultivars except the latest.

The quantitative analysis of the inherent anti-nutrients in the mango kernels showed significant differences in the level of various anti-nutrients that were determined (Table 4). The range of values obtained for the anti nutrients of the mango kernels are tannin (37.30 – 163.33g/kg), phytate (0.442 – 0.897mol/kg) and oxalate (18.74 – 54.24mg/100g). The values obtained for the tannin content of Oori (157.33g/kg) and Alphonso (163.33g/kg) and the values obtained for the oxalate content of Oori (54.24mg/100g) and Alphonso (49.55mg/100g) are significantly higher ($p< 0.05$) than the values obtained for the other mango cultivars. While, the values obtained for the oxalate content of Mabranka (0.442mol/kg), Alphonso (0.453mol/kg) and Indesina (0.478mol/kg) are significantly lower ($p< 0.05$) than the values recorded for the other mango cultivars (Table 4). The pH range of 4.10 – 5.80 which also contained titratable acidity of between 9.92 – 64.35mg/100g showed that the kernels are highly acidic irrespective of the cultivar's used. The level of crude protein, crude fat and total carbohydrates recorded for the mango cultivars are similar to previous work done on a local mango cultivars from Culiacan, Mexico (Zazueta – Murales, 2006). The amount of nutrients in mango kernels, especially the crude protein, crude fat and total carbohydrates showed that the kernels have high potential as energy sources and may be better utilized as a source of energy for animal feeding purpose.

Table 1: Physical characteristics of mango kernels from different cultivars

	Physical characteristics					
Identified Mango cultivars	SFR (%)	KFR (%)	KSR (%)	KV (cm^3)	BKD (g/cm^3)	KDM (mm)
Alphonso	8.82^{b}	4.89^{bc}	55.49^{c}	11.72^{b}	1.081	53x26x13
Julie	6.36^{a}	2.38^{a}	36.22^{a}	7.69^{a}	1.073	42x21x9
Kent	8.73^{b}	5.32^{c}	62.72^{de}	21.04^{ef}	1.131	67x33x16
Mabranka	12.25^{c}	5.57^{c}	45.82^{b}	17.37^{cd}	1.056	63x33x14
Magadugu	8.60^{b}	4.96^{bc}	57.56^{cd}	17.74^{cd}	1.103	62x37x14
Peach	7.00^{a}	4.09^{b}	59.57^{cde}	28.22^{g}	1.159	75x43x16
Peter	9.70^{b}	5.31^{c}	55.60^{c}	24.03^{f}	1.069	64x43x17
Indesina	11.84^{c}	7.18^{d}	60.05^{cde}	12.51^{b}	1.145	66x25x11
Taymour	9.57^{b}	4.73^{bc}	49.85^{b}	13.95^{bc}	1.108	60x25x12
Oori	17.21^{d}	10.79^{e}	63.35^{e}	20.00^{de}	1.116	63x35x17
SEM	1.89	0.99	32.02	15.00		

Values are means of ten replicates determinations; SEM = Standard error of mean

abc... = means on the same column followed by different superscripts differ significantly ($p<0.05$)

SFR = Seed to fruit weight ratio; KFR = Kernel to fruit weight ratio; KSR = Kernel to seed weight ratio; KV = Kernel volume;

BKD = Bulk density; KDM = Kernel dimension.

Table 2: Nutritional characteristics of different cultivars of mango kernel

Mango cultivars	Nutrient composition (%)							
	Dry matter	Crude protein	Crude fat	Crude fibre	Total ash	Total CHO	pH*	Titratable acidity* (mg/100g)
Alphonso	54.70^{c}	6.87^{b}	13.50^{g}	2.65^{abc}	1.90d^{e}	75.09^{a}	4.30^{a}	41.07^{f}
Julie	35.43^{a}	7.88^{d}	5.96^{a}	3.80e^{f}	0.52^{a}	81.84^{d}	5.20^{e}	19.23^{b}
Kent	54.69^{c}	7.41^{c}	10.74^{e}	3.08^{cd}	2.23^{e}	76.54^{b}	5.12^{e}	20.99^{b}
Mabranka	43.76^{b}	6.24^{a}	13.10^{fg}	2.61^{abc}	3.04^{f}	75.02^{a}	4.10^{a}	64.35^{g}
Magadugu	53.19^{c}	6.82^{bc}	9.11^{d}	3.34^{de}	3.54^{g}	77.18^{b}	4.99^{d}	23.90^{c}
Peach	56.49^{c}	6.84^{bc}	12.60^{f}	2.87^{bcd}	1.21^{bc}	76.48^{b}	4.58^{b}	27.48^{d}
Peter	32.67^{a}	6.62^{b}	5.92^{a}	2.22^{a}	2.20^{e}	83.04^{d}	5.07^{de}	27.05^{d}
Indesina	55.11^{c}	8.05^{d}	7.71^{b}	3.25^{d}	2.41^{e}	78.57^{c}	4.77^{c}	28.96^{d}
Taymour	54.07^{c}	7.18^{c}	8.45^{c}	3.95^{f}	0.99^{ab}	79.44^{c}	4.18^{a}	37.89^{e}
Oori	57.23^{c}	8.19^{d}	8.60^{cd}	2.42^{ab}	1.61^{cd}	79.17^{c}	5.80^{f}	9.92^{a}
SEM	7.93	0.12	0.12	0.09	0.08	0.49	0.00	2.37

abc.... = means on the same column followed by different superscripts differ significantly (p<0.05)

Values are means of three replicates determinations; SEM = Standard error of mean;

* = Result based on wet matter basis

Table 3: Qualitative screening of anti-nutrients in mango kernels

Mango cultivars	Saponin	Tannin	Steroids	Flavonoid	Phen-olic Compd	Cyano-genic glyco-sides	Alka-loids	Oxalates	Phytate	Triterpene
Alphonso	-	+	-	+	+	+	-	+	+	-
Julie	-	+	-	+	+	-	-	+	+	-
Kent	-	+	-	+	+	-	-	+	+	-
Mabranka	-	+	-	+	+	+	-	+	+	-
Magadugu	-	+	-	+	+	+	-	+	+	-
Peach	-	+	-	+	+	-	-	+	+	-
Peter	-	+	-	+	+	+	-	+	+	-
Indesina	-	+	-	+	+	+	-	+	+	-
Taymour	-	+	-	+	+	+	-	+	+	-
Oori	-	+	-	+	+	Trace	-	+	+	-

Key: + detected; - Not detected

Table 4: Quantitative assessment of anti-nutrients in mango kernels

Mango cultivars	Anti-nutrient composition		
	Tannins (g/kg)	Phytate (mol/kg)	Oxalates (mg/100g)
Alphonso	163.33^{i}	0.453^{a}	49.55^{de}
Julie	147.73^{g}	0.604^{b}	38.55^{c}
Kent	115.67^{f}	0.897^{d}	18.74^{a}
Mabranka	37.30^{a}	0.442^{a}	22.07^{a}
Magadugu	67.57^{d}	0.538^{ab}	20.30^{a}
Peach	108.00^{e}	0.540^{ab}	30.96^{b}
Peter	45.90^{b}	0.512^{ab}	38.56^{c}
Indesina	73.20^{d}	0.478^{ab}	24.24^{a}
Taymour	57.67^{c}	0.512^{ab}	38.56^{d}
Oori	157.33^{h}	0.744^{c}	54.24^{e}
SEM	11.48	0.004	11.82

Values are means of three replicates determinations; SEM = Standard error of mean
abc.... = means on the same column followed by different superscripts differ significantly (p <0.05)

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