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Comparative Characteristics Study of Moringa (Moringa peregrina), Terminalia (Terminalia Billerica) and Tiger nut (Cyperus esculentus) Oils

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Abstract

Vegetable oils constitutes are an important part of human diets. The objective of this research is to study the utilizing the seeds of Terminalia bellerica, Moringa peregrine, and tubers of Tiger nut to produce oils that can be utilized successfully as sources of edible oil for human consumption. Fatty acids compositions of oils were analyzed by GLC, phenolic compounds of oils and meals were identified and determined using HPLC, minerals content of meals were analyzed by atomic absorption spectrophotometer. Also, amino acid content of meals determination by amino acid analyzer. Moringa peregrina seed had the highest oil content (50.09 %) followed by Terminalia bellerica seed (36.01%) and Tiger nut (19.33 %) respectively. Moringa peregrina recorded the highest oxidative stability compared to the stability of Terminalia and Tiger nut oil. Moringa peregrina seed oil had the highest percentage of oleic acid (76.91%) followed by Tiger nut tubers oil (69.53%), but Terminalia bellerica seed oil had the lowest percentage (27. 09 %). Moringa peregrina seed oil contained a higher amount of total tocopherols compared to other samples. The result indicates that Moringa peregrine and Terminalia bellerica, and Tiger nut oil could be used as a good source of edible oil.

Keywords: fatty acids composition, total tocopherols, minerals, amino acid, and phenolic compounds

1. Introduction

Moringa peregrina is a promising candidate for future crop. The tree is known to be drought resistant and have very valuable nutrient and medicinal *properties*. Saudi Arabia is one of the main native distribution areas of *M. peregrina* in the Middle East [1]. *Moringa peregrina* is used in folk medicine and grows widely in the tropical and subtropical regions of Africa and India [2]. Moringa is among the most highly valued and cultivated trees all over the world because of its medicinal and nutritional properties. It is also a good source of oil [3]. Oil content from *Moringa peregrina* seeds (from Saudi Arabia) was 49.8%. physical and chemical characteristics of extracted oil were: refractive index 1.460 at 40C, acidity (as oleic) 0.30%, iodine value 69.6, saponification number 185 and peroxide value 0.4 meq/kg. *Moringa peregrina* seed oil was found to contain high levels of oleic (70.52%), followed by gadoleic (1.5%), while the dominant saturated acids were palmitic (8.9%) and stearic (3.82%), α-tocopherols were detected at levels of 145mg/kg [4]. Moringa is characterized by high levels of potassium (K). Patients with the COVID-19 virus have a decrease in potassium levels in the body he justifies the application of Moringa for coronaviruses [5]

The three Terminalia trees (*Terminalia chebula* Retz, *Terminalia bellerica*-and *Terminalia horrida*) belong *to* the family Combretaceae and are widespread in Egypt and other-subtropical and tropical regions.

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The fruits are called black or chebulic myrobalans and are used in the leather tanning industry and local traditional folk medicine in Egypt, India, and Pakistan. Their trivial names in Egypt are Kebuli (T. chebula), Hind (T. horrida. Methanolic and aqueous extracts of Terminalia have been reported to exhibit a variety of biologic antioxidants, anti-anaphylactic, antidiabetic, anti- mutagenic, anticancer, antimutagenic antimicrobial, antiviral, antimalarial, and antifungal activities [6]. The seeds of *Terminalia bellirica* Roxb. is a valuable tree of Indian forests. The seeds are valued-medicinally and also industrially, for tanning-purposes. The kernels have 40% oil and 35% protein. The oil extracted from the kernels-is sweet- smelling and has palmitic (35%), oleic (24%) and linoleic (31%) acids a major fatty acid [7]. *Terminalia belleriea* fruit is known for its medicinal properties and is currently exploited by manufacturers of Indian traditional ayurvedic medicines. Apart from its abundance in some states of India, organized farming of this tree has been started in some places. The seed of this fruit was found to be a good source of oil (38%) [8]. The chemical composition: Moisture, ash, and crude fiber contents of the seed kernel were found to be 8. 43, 2.54, and 8.78% respectively [9]. The oil was found to contain oleic acid (43.1%), palmitic acid (28.3%), linoleic acid (17.0), and stearic acid (10.6%) as major fatty acids, the total tocopherol content was found to be about 660 ppm. The fruit of *Terminalia bellerica* is generally regarded as safe for human consumption [8]. The fatty acids of the oil obtained from Terminalia seeds had a chain length between C14 to C22. The oil contained 17.70% myristic acid, 21.6% palmitic acid, 45.67% oleic acid, and 14.93% stearic acid. The whole kernel was analyzed for some nutrients and minerals. The kernel contained 22.57 and 8.38% total lipid and protein respectively. It also contained Ca, Mg, K, Na, P, Fe, Mn, Zn, and Cu were found to be 0.3, 0.02, 0.2, 0.2, 0.01%; 23, 1, 12, and 12 ppm respectively in kernel [9]. The oil of *Terminalia bellirica* showed high content of tocopherol (0.05%). Among eleven metals (Ca, Cu, Zn, Mg, Mn, Fe, Pb, Cd, As, Na, K) in all the six fatty oil contents, Pb and Cu showed high concentrations while, Fe values of all the oil contents were below the permissible concentrations [10].

Tiger nut (*Cyperus esculentus L.)* is an edible perennial grass-like plant native to the old world, and is a lesser-known vegetable that produces sweet nut-like tubers known as earth Almonds. Tiger nut is also known by various other names as chufa (in Spanish), earthnut, yellow nut sedge, groundnut, rushnut, and edible galingale. The tubers contain about 25 % oil, which is resistant to peroxidation, 50 % digestible carbohydrates, 4 % protein, and 9 % crude fiber [11]. Tiger nut belongs to the Division-Magnoliophyta Class-Liliopsida Order-Cyperales-and Family Cyperaceae [12]. Tiger nut produces high-quality oil about 25.5% of its content. The nut is high in oil content. Tiger nut oil has a composition similar to olives and a rich mineral content. Tiger nut oil is highly unsaturated fatty acids and good for the health of humans. Tiger nut oil contributes to the reduction of cholesterol it reduces the risk of coronary heart diseases and atherosclerosis. The oil is golden brown and has a rich, nutty taste [13,14]. Tiger nut was reported as healthy and it helps in the prevention of heart attacks, thrombosis and activates blood circulation. It helps in preventing cancer due to the high content of soluble glucose. It was also found to assist in reducing the risk of colon cancer. The proximate of tiger nut typically, 7% proteins, 26% fats (oils), 26% fiber [15]. Tiger nut oil had a golden color. The values of refractive index, acidity, saponification number, iodine value, peroxide value, and saponifiable matter of tiger nut oil were similar to edible oils. Regarding the iodine value the tiger nut oil could be classified as non-drying oil. The oil has four main fatty acids, linoleic (5. 5%), palmitic (15.4%), arachidic (6.1%) and oleic acid being the most abundant (65.8%). The fatty acid content of oil showed 71% unsaturation tiger nut oil could be a good source of edible oil and essential fatty acids tiger nut oil had a total tocopherol content of 97.4mg/100g [16]. Tiger nut is a rich source of phytochemicals, oil, fiber carbohydrates, mineral elements and contain moderate amounts of protein. The phytochemical constituents of the tiger nuts are important and could be of high commercial [17].

The aim of this investigation was the comprehensive characterization of the physicochemical, fatty acid composition, and phenolic compounds in their seeds oil, *Moringa peregrine*, *Terminalia bellerica* seeds oils, and Tiger nut oil as a source of edible oils, also to comparative the mineral and amino acid composition of their meals.

2. Materials and Methods

2.1. Materials

Moringa peregerina* seeds (*Moringa peregerina) were obtained from Marsa Alam Elkoser the Red Sea Governorate, Egypt.

***Terminalia bellerica* seeds (*Terminalia bellerica*)** were obtained from Giza Zoo, Giza, Egypt.

Tiger nut *(Cyperus esculentus*) tubers were obtained from the local market in Cairo, Egypt.

Chemicals reagents: All chemical and reagents of the analytical methods used in the present study were analytical grade purchased from Sigma-Aldrich Company for chemicals, USA and El-Gamhouria Company for Chemicals and Drugs, Egypt. Pure standards of fatty acids methyl esters and standards

phenolic compounds used in this study were obtained from Koch light Laboratories, Ltd, England**.**

2.2. Methods:

Proximate Analysis: Moisture, protein, total fat, crude fiber, and ash contents were determined [18] while carbohydrate was calculated by difference.

Extraction of the oils: *Moringa peregrina*, *Terminalia bellerica* seeds, and Tiger nut tubers used hydraulic press extraction [19].

Physico-chemical properties of oils: Refractive index, color, acid value, peroxide value, Saponification value, and unsaponifiable matter were determined [18]. Iodine value, calculated from fatty acids [20].

Oxidative stability: The oxidative stability of oils was estimated [21] using 679 rancimate (Metrohm Co. Switzerland), at 100°C with an airflow rate at 20L/hr.

Fatty acids determination: Fatty acids analysis and determination were carried out by preparation of methyl ester followed by the identification of methyl esters using an Agilent 6890 series gas chromatography apparatus equipped with a DB23 (60 m X 0.32 mm X0.25 µm capillary column (Agilent Technologies Inc., CA, USA) [22].

Total phenols content was determined in oil and meal of samples under study [23, 24], and results were expressed as mg of caffeic acid per kg.

Phenolic compounds of samples were identified and determined using HPLC method [25].

***α*- tocopherols (ppm)** were determined according to Wong, *et al.,* [26].

Antioxidant activity was analyzed using the stable diphenyl-1-picryl-hydrazine (DPPH) [27].

Minerals Analysis: The method described by AOAC (2016) [18] was used for mineral analysis. The ash was digested with 3 ml of HCl and made up to the mark in a 100 cm standard flask with 0.36 ml HCI before the mineral elements were determined by atomic absorption spectrophotometer (Agilent Technologies 4210 MP-AES).

Amino acids composition using HPLC- Pico-Tag: The amino acid composition of experimental samples was determined using HPLC-Pico-Tag [28].

Statistical analysis: The obtained data were statistically analyzed by the least significant differences (L.S.D) at the 5 % level of probabili [29] using version of costat 6.451.

Chemical Composition of Moringa *Peregrina* seeds, *Terminalia* bellerica seeds and Tiger nut tubers; moisture content, crude protein, oil content, ash content, crude fiber and total carbohydrates are shown in Table (1): The results revealed that moisture content was found to be 4.41, 5.27 and 11.14%, the crude protein was 25.65, 35.11 and 4.19%, the oil content was 50.09, 36.01 and 19.33%, ash content was 3.06, 3.63 and 2.54%, crude fiber 3.31, 2.47 and 6.49%, and the total carbohydrate was 13.48, 17.51 and 56.31%for the previous samples, respectively. [30,1,17,16].

Physical and chemical characteristics of oils play an important role in assessing these quality assurance palatability and consumer acceptability as well as they are related with the healthy safe quality criteria of these oils by using them. There are many physical characteristics of edible oils such as Refractive index and color. Chemical quality assurance criteria including acid value, peroxide value, unsaponifiable matter iodine number, saponification value and oxidative stability.

The results in the table (2) revealed that the refractive index of *Moringa Peregrina* seeds oil, *Terminalia bellerica* seeds oil and Tiger nut tubers oil was determined to be 1.4671, 1.4715, 1.4675 respectively, color was 1.97, 0.57 and 5.9 in red Lovibond scale, but it was 35, 30 and 34.4 in yellow scale for the same previous samples respectively. The results in the same table showed that acid value were 0.32, 0.21 and 0.74(mg KOH/g oil). The variation in acid values of samples under study due to acidity is generally affected by various factors related to both hydrolysis and oxidation of the oil.

The peroxide value of the Moringa, Terminalia and Tiger nuts oils was 0.51, 0.51 and 0.50(meq O_2 /kg oil), the meanwhile unsaponifiable matter was 0.75, 0.92, and 1.19(%) and oxidative stability at 100^{o}C was 117,16 and 26 (hr.) for the same previous samples, respectively.

The iodine number was 70.02, 112.49 and 76.51(g I_2/100g oil). Saponification value was 198.46, 202.07 and 199.99 (mg KOH/g oil) for the same mentioned respectively [30,31,8,32,17,33]. This difference in the physical and chemical properties of this oil may be due to the genotype for each plant under investigation.

The results in the Table (3) also revealed that the Moringa seeds oil, Terminalia seeds oil, and Tiger nut oil contained low amounts of saturated fatty acids represented 19.03, 23.56, and 22.31% compared with total unsaturated fatty acid in the same mentioned oils, respectively. With regarding the results, it could be noticed that the major saturated fatty acid was palmitic acid in all samples. While, oleic acid was the predominant unsaturated fatty acid in Moringa seeds oil and Tiger nut oil was 76.91and 69.53%, respectively. While, linoleic acid in Terminalia oil was 48.77%.

Table 1: Proximate analysis of samples on fresh weight bases.

Components (%)	Samples			
	Moringa seeds	Terminalia seeds	Tiger nut tubers	LSD
Moisture content	$4.41^{c} \pm 0.34$	$5.27^{b}\pm0.04$	$11.14^{a}\pm0.10$	0.41
Crude Protein	$25.65^{b}\pm0.08$	$35.11^{a}\pm0.05$	$4.19^{c}\pm0.06$	0.13
Oil content	$50.09^{a}\pm0.33$	$36.01^{b}\pm0.55$	$19.33^{c}\pm0.29$	0.81
Ash content	$3.06^{b}\pm0.11$	$3.63^{a} \pm 0.03$	$2.54^{c}\pm0.11$	0.19
Crude Fiber	$3.31^{b}\pm0.02$	$2.47^{c}\pm0.02$	$6.49^{a}\pm0.02$	0.24
Total carbohydrates	$13.48^{c}\pm0.65$	$17.51^{b}\pm0.62$	$56.31^{a}\pm0.12$	1.05

- Mean values in the same raw with different letters are significantly different ($P \leq 0.05$).
- Values are means ± standard deviation of three determinations.
- Total carbohydrate = 100- (Moisture + Crude protein + Crude lipids + Total ash + Crude fiber)

Table 2: Physical and chemical properties of oils

Physical and chemical characteristics of oils		Extracted oils			
		Moringa seeds	Terminalia seeds	Tiger nut tuber	LSD
Refractive index at 25°C		$1.4671^{c} \pm 0.0001$	$1.4715^{a} \pm 0.001$	$1.4675^{b}\pm0.0001$	0.0002
Color	Yellow	$35^{a} \pm 1$	$30^{c}\pm1$	$34.4^{b}\pm1$	0.24
	Red	$1.97^{b}\pm0.06$	$0.57^{c}\pm0.06$	$5.9^{a}\pm0.1$	0.15
Acid value (mg KOH/g oil)		$0.32^{b}\pm0.005$	$0.21^{c}\pm0.01$	$0.74^{a} \pm 0.025$	0.03
Peroxide value (meq O2 / kg oil)		$0.51^{a} \pm 0.01$	$0.51^{a} \pm 0.01$	$0.50^{a} \pm 0.55$	0.02
Iodine value (gI_2/100g oil)		70.02	112.49	76.51	
Saponification value (mg KOH/g oil)		$198.46^{a} \pm 1.68$	$202.07^{a} \pm 1.85$	$199.99^{a}\pm1.99$	3.691
Unsaponifiable matter (%)		$0.75^{c}\pm0.03$	$0.92^{b} \pm 0.06$	$1.19^{a} \pm 0.05$	0.1
Oxidative stability at 100°C (hr.)		117	16	26	

- Mean values in the same raw with different letters are significantly different ($P \leq 0.05$).
- Values are means ± standard deviation of three determinations.

Table 3: Relative percentage of fatty acids composition of extracted oils

Fatty acids	Fatty acids composition of oils%		
	Moringa seeds	Terminalia seeds	Tiger nut tubers
C14:0	0.08	0.04	0.10
C16:0	8.72	16.75	14.86
C16:1	1.89	0.27	0.28
C17:0	0.11	0.12	0.06
C17:1	0.06	0.03	0.04
C18:0	4.95	5.94	6.15
C18:1	76.91	27.09	69.53
C18:2	0.42	48.77	7.52
C18:3	0.02	0.12	0.15
C20:0	2.43	0.56	0.93
C20:1	1.67	0.16	0.17
C22:0	2.74	0.15	0.21
Total unsaturated fatty acids(Tus)	80.97	76.44	77.69
Total saturated fatty acids(Ts)	19.03	23.56	22.31
Tus/Ts	4.25	3.24	3.48

On the other hand, linolenic acid recorded the lowest value in the unsaturated fatty acid, it was 0.02, 0.12, and 0.15 in Moringa seeds oil, Terminalia seeds oil, and Tiger nut oil, respectively, also the ratio of the total unsaturated /total saturated fatty acid (Tus/ Ts) was 4.25, 3.25 and 3.48%, respectively [3,1,8,10,32,33].

Results in the table (4) showed the phenolic compounds of *Moringa peregrina* seeds oil, *Terminalia bellerica* seeds oil, and Tiger nut oil determined by HPLC, analysis it could be noticed that oleuropin was the major phenolic compounds 10.65, 15.76, and 14.51 ppm in the same above samples, respectively followed by salicylic acid (4.43) and (pyrogallol 2.48 ppm) in Moringa, ellagic acid was1.33 and ferulic acid 1.11ppm in Terminalia and ferulic acid 1.64, ellagic acid was 1.55 ppm in Tiger nut [34,35].

It is clear from the data presented in Table (5) that the main minerals in meals of *Moringa peregrina*,

Terminalia bellerica and Tiger nut were potassium element 657.66, 891.15 and 512.72 and calcium 254.18, 916.69 and 48.41 mg/100 gm for meal in Moringa,Terminalia and Tiger nut respectively. But phosphor and Magnesium elements were (164.47, 121.50), (148.19, 125.77) and (92.85, 71.98) (mg/100gm) for Moringa, Terminalia and Tiger nut meal, respectively. On the other hand, the lowest content of minerals was noticed for Zinc, Manganese, Sodium, and Iron. Sodium element was the highest value in Tiger nut meal (272.65) (mg/100 gm) [2,10,9,17,33].

A total of *seventeen* amino acids was identified in meal of Moringa, Terminalia, and Tiger nut.

The amino acids compositions of meals of *Moringa peregrina*, *Terminalia bellerica* and Tiger nut are presented in table (6)

Tyrosine acid was the most predominant amino acid which amounted to 87.54, 92.12 mg/gram, followed by Glutamic acid was 63.37, 80.47 mg/gram in meal of Moringa and Terminalia respectively but the major amino acid was glutamic acid 13.70 mg/gram, followed by tyrosine was 12.00 mg/gram in meal of Tiger nut tuber. On the other hand, the lowest content of amino acids in meals of the previous samples was cysteine 1.11, 1.02, and 0.03 mg/gram, respectively [30,7,33]

From listed the data in table (7) the phenolic compounds of meal of Moringa, Terminalia, and Tiger nut determined by HPLC analysis it could be observed that salicylic acid, catechin and pyrogallol were the main components (207.32, 182.59, and 162.90 ppm) in *Moringa peregrina* meal and oleuropin, pyrogallol, and vanillic acid were the predominant compounds (433.29, 192.15, and 182.63 ppm) in *Terminalia bellerica* meal. While, the main components were oleuropin, pyrogallol, and catechin compounds (165.66, 141.41, and 91.34 ppm) in Tiger nut meal respectively.

While, the minor compounds were catechol compound 10.23 ppm in Moringa, gallic acid in Terminalia 4.39 ppm but catechol in Tiger nut 2.51 ppm. similar results were mentioned by [2,6,34]. discovered that a high polyphenol content was associated with high resistance of oxidation [23].

Results in Table (8) show that the content of tocopherol in oils of *Moringa peregrina* seeds, *Terminalia bellerica* seeds, and Tiger nut tuber. Moringa seeds oil has remarkable higher amounts from tocopherol contents (239.47 ppm) followed by Tiger nut (89.67 ppm) and Terminalia (34.15 ppm) [3,30,8,10,32]. Thus, tocopherols present in a high concentration in Moringa seeds oil which would be expected to contribute to excellent oxidative stability and protection during storage and processing [36].

Also, in the same previous table (8) total phenols content in oil was 14.67, 5.03 and 4.69 ppm in *Moringa peregrina*, *Terminalia bellerica* and Tiger nut oil, respectively. [35], but total phenols in their meals were 210.25, 606.37 and 64.94 ppm, respectively [2,6,10,37].

Table (9) Antioxidant activity of *Moringa peregrina*, *Terminalia bellerica* and Tiger nut was 12.79, 13.69, and 16.84 % in their oils and 21.96, 93.92, and 39.04 % in meals, respectively [35,10,6,32,37].

The *DPPH* radical has been widely used to test the potential of compounds as free radical scavengers of hydrogen donors and to investigate the antioxidant activity of plant extracts [38].

Table 4: Identification of phenolic compounds of oils

Phenolic compounds (ppm)	Phenolic compounds of oils		
	Moringa seeds	Terminalia seeds	Tiger nut tubers
Pyrogallol	2.48	0.58	1.23
Gallic acid	0.08	0.03	0.09
3-OH tyrosol	0.19	0.09	0.05
Catechol	-	0.02	0.01
4-amino-benzoic acid	0.16	0.03	0.02
Catechein	1.59	0.62	0.16
Chlorogenic acid	1.32	0.29	0.47
P-OH- benzoic acid	0.47	0.28	0.38
Vanillic acid	1.06	0.39	0.31
Caffeic acid	0.24	0.29	0.16
Caffeine	0.43	0.19	0.26
Ferulic acid	1.16	1.11	1.64
Salicylic acid	4.43	0.47	1.03
Ellagic acid	2.29	1.33	1.55
Coumarin	0.50	0.58	0.23
Oleuropin	10.65	15.76	14.51
Benzoic acid	1.04	-	-

Table 5: Minerals contents of meals

Minerals contents of meals (mg/100 gm)	Minerals contents of meals		
	Moringa seeds	Terminalia seeds	Tiger nut tubers
Zinc (Zn)	6.12	2.36	2.26
Potassium (k)	657.66	891.15	512.72
Magnesium (Mg)	121.50	125.77	71.98
Manganese (Mn)	1.60	1.23	0.78
Sodium (Na)	16.53	27.23	272.56
Calcium (Ca)	254.18	916.69	48.41
Phosphor (P)	164.47	148.19	92.85
Iron (Fe)	2.67	1.11	11.54

Table 6: Amino acids composition of meals

Amino acids (mg/ gram)	Amino acids composition of meals		
	Moringa seeds	Terminalia seeds	Tiger nut tubers
Aspartic	8.17	19.6	1.76
Glutamic	63.37	80.47	13.70
Serine	6.00	8.55	1.18
Glycine	8.77	9.99	1.40
Histidine	6.13	6.08	0.48
Arginine	31.28	44.83	4.74
Threonine	7.14	7.84	0.40
Alanine	19.28	21.13	1.86
Proline	9.28	11.64	1.72
Tyrosine	87.54	92.12	12.00
Valine	15.93	21.26	1.46
Methionine	9.73	7.51	0.53
Cysteine	1.11	1.02	0.03
Isoleucine	22.64	27.12	1.84
Leucine	19.80	21.85	2.05
Phenylalanine	23.32	24.32	1.98
Lysine	16.10	26.43	2.65

Table 7: Phenolic compounds of meals

Phenolic compounds (ppm)	Phenolic compounds of meals		
	Moringa seeds	Terminalia seeds	Tiger nut tuber
Pyrogallol	162.90	192.15	141.41
Gallic acid	11.71	4.39	4.35
3-OH tyrosol	46.48	46.11	17.53
Catechol	10.23	16.41	2.51
4-amino-benzoic acid	22.45	10.98	3.49
Catechin	182.59	69.65	91.34
Chlorogenic acid	119.27	49.88	72.38
P-OH- benzoic acid	91.56	117.59	20.78
Vanillic acid	25.98	182.63	19.99
Caffeic acid	73.13	46.47	7.66
Caffeine	11.11	18.29	7.07
Ferulic acid	77.31	27.59	29.41
Salicylic acid	207.32	83.15	51.76
Ellagic acid	100.69	40.57	13.76
Coumarin	54.02	42.62	16.09
Oleuropin	-	433.29	165.66
Benzoic acid	-	-	26.84

Table 8: Some natural antioxidants in oils and meals

Natural antioxidants (ppm)	Moringa seed	Terminalia seed	Tiger nut tuber	LSD
Total tocopherols in oil	$239.47^{a} \pm 0.27$	$34.15^{c} \pm 0.07$	$89.67^{b} \pm 0.04$	0.33
Total phenols in oil	$14.67^{a} \pm 0.03$	$5.03^{b} \pm 0.01$	$4.69^{c} \pm 0.03$	0.058
Total phenols in meal	$210.25^{b} \pm 1.25$	$606.37^{a} \pm 0.13$	$64.94^{c} \pm 0.44$	1.54

- Mean values in the same raw with different letters are significantly different ($P \leq 0.05$).
- Values are means ± standard deviation of three determinations.

Table9: Antioxidant activity of oils and meals

Antioxidant activity (%)	Moringa Seeds	Terminalia Seeds	Tiger nut tubers	LSD
Oils	12.79^{c} ±0.09	13.69^{b} ±0.25	16.84^{a} ±0.65	0.805
Meals	21.96^{c}± 0.23	93.92^{b} ± 0.55	39.04^{b} ± 0.92	1.267

- Mean values in the same raw with different letters are significantly difference ($P \leq 0.05$).
- Values are means ± standard deviation of three determinations.

3. Conclusion

The result presented in this paper indicate that *Moringa peregrine* and *Terminalia bellerica* have great potential as a food or feed due to their high content of oil, protein, essential amino acids, and unsaturated fatty acids, Tiger nut was a good source of oil and carbohydrate which useful for human nutrition

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