IJRD International Journal of Research & Development Organisation
ISSN: 2455-7668
Journal of Agricultural Research

Stability of Moringa Seed Oil Compared to Some Vegetable Oils in Sudan

Babiker M. Elhassan Babiker and Mahdi Abbas Saad Shakak*

*Department of Food Science and Technology, College of Agricultural Studies, SUST, Sudan.

This study was conducted to see general characteristic and stability of moringa seed oil in comparison with oils of groundnut, sunflower and cottonseeds in frequent frying process. Moringa seed oil was purchased from Omdurman local Market. Refractive index, density viscosity, colour red, yellow and blue and oil content which were 1.4640, 0.9190, 20.22, cp 5.00, 1.30, 0.00 and38.6% receptively. The chemical properties of moringa seed oil showed peroxide value 2.79 meqO_2/kg , free fatty acids 1.40% and fatty acid composition exhibited oleic, linoleic, stearic, behenic and palmatic acids (45.09 , 42.43 , 8.38 , 1.77 , 0.52%) respectively. There were significant difference ($p \leq 0.05$)among refractive index , density , viscosity colour of moringa seed oil when they compared to sunflower seed , cottonseed , and groundnut oils before frying and after frying periods . Also there were significant difference in chemical properties among peroxide value and free fatty acids of moringa seed oil compared to sunflower, cottonseed and ground nut oils before frying and after frying time, also there was significant difference in sensory characteristics of taste, flavour, colour, texture and over all acceptability of potato chips fried in moringa seed oil compared to sunflower seed, cotton seed and groundnut oils .It is observed that potatoes chips fried by moringa oil was better than those fried by other oils.

Introduction

Moringa is considered one of the world trees most useful as almost every part of it can be used for food, or has some other beneficial properties. In the tropics it is used as forage for livestock and in many countries, is used as micronutrient powder to treat indigenous diseases (NRC, 2006).

In the Sudan, dry *Moringa oleifera* seeds are used as substitute for alum by rural women to treat highly turbid Nile water (Jahan, 1986). A large number of reports on nutritional qualities of moringa now exist in both the scientific and popular literature.

The seed oil contains all the fatty acids contained in olive oil, except linoleic and was used as its acceptable substitute (Morton, 1991; Khatab and Shakak 2012).

The seeds contain between 33 and 44 % w/w of vegetable oil (Sengupta and Gupta, 1970; Khatab and Shakak 2012).

The oil is high in oleic acid (>70%).Oil that are high in mono unsaturated /oleic acid can be used as a healthier alternative to the more saturated and hydrogenated oils used in frying because of their stability. Consumption of saturated and partially hydrogenated fats and oils has been shown to increase the risk of coronary heart disease (Mattson and Grundy, 1985; Mansink and Katan, 1990).

Moringa seed oil is a good source of behanic acid (9%) in nature and is used as preservative in food industries; the oil is liquid at ambient temperature, translucent and pale yellow in colour . The oil does not turn rancid and also burns without smoke (Fuglie, 1999; Khatab and Shakak 2012). The aim of this study is to determine the physicochemical properties and the stability of moringa seed oil compared to other vegetable oils (groundnut, sunflower seed and cottonseed oils) sold in Sudan. Also to evaluate the quality acceptability of potato chips fried in moringa oil, compared to those fried in above mentioned oils.

Materials and Methods

Moringa seed oil was brought from Omdurman market, Sunflower seed oil was brought from Arab Sudanese Vegetables Oil Company limited, (Khartoum North) Cottonseed oil and groundnut oils were purchased from local market of Khartoum in Sudan. Three kg of potato were peeled and sliced, kept in water to reduce the browning before frying and divided to four parts for frying, 600 ml of each oil using a frying pot in first day then the oil drawn and kept to next day in clean plastic container and made second and third frying and oils cooled to analysis. The frying was carried out using moringa, sunflower, cottonseed and groundnut oils (Ibrahim, 2000); Shakak *et.al.* 2015). At the end of frying process excess oil from chips was allowed to cool on absorbent tissue (Mostafa, *et. al.* 1996).

Oil content, refractive index (RI),oil density , peroxide value (PV) ,free fatty acids (FFA) , colour were determined according to the AOAC method (2010). The viscosity of oil samples was determined by using Oswald — u- Tube, viscometer No 7647

(A.O.C.S, 2006). Fatty acid composition of oil was determined by gas chromatography apparatus (Py E-UNICAM model GCD).-ACMLT, 1990).

Results and Discussion

1- Oil content and physical properties of moringa seed oil

Table 1 shows that oil content, refractive index density, viscosity and colour of moringa seed oil. The oil content of moringa seeds was 38.36% which was lower than those reported by Salah (2006); Anwar and Rashid, (2007) and Khatab and Shakak, (2012). Which were 39.1%, 40.39% and 43.79, respectively, yet, the value was higher than 25.1% reported by Lalas and Tsakins (2002) .

The refractive index of moringa oil was 1.4640 which was lower than 1.4670 reported by Khatab and Shakak 2012), but Similar to value 1.4640 reported by Salah, (2006) and was higher than those values reported by Tsakins *et.al*. (1999) and Anwar and Rashid (2007) which were 1.4549 and 1.4608 respectively.

The density of moringa oil was 0.9190 this value was higher than those reported by Tsakin *et.al*. (1999); Lalas and Tsaklins, (2002) and Khatab and Shakak, (2012). which were 0.8809 , 0.9090 and 0.8999, respectively, but was Lower than 0.9469 reported by Salah, (2006) .

Viscosity of moringa oil 20.22 Centipoise (cp), it was Lower than values reported by Tsakins *et.al*. (1999); Lalas and Tsakins, (2002); Salah (2006) and Khatab and Shakak, (2012) which were 57, 45.5, 45.82 and 35.6 cp respectively.

The colour of moringa oil were 5.00 , 1.30 and 0.00 for red , yellow and blue, respectively , these values in red color were higher than those reported by Lalas and Tsakins, (2002); Salah, (2006) and Khatab and Shakak, (2012), which were (0.2 , 1.5 and 0.1), respectively, but value obtained in yellow colour was lower than those

reported by Lalas and Tsakins, (2002); Salah, (2006); Anwar and Rashid, (2007) and Khatab and Shakak, (2012) which were (3.14 , 6.3 , 7.12 and 4.00), respectively.

2- Chemical properties of moringa seed oil

Table 2 shows peroxide value and free fatty acids of moringa oil.

The peroxide value of moringa oil was 2.79 This value was lower than that reported by Salah, (2006) which was 9 meq O_2 / kg oil , but was higher than that values reported by Tsakins *et ,al* (1999); Lalas and Tsakins, (2002); Anwar and Rashid, (2007) and Khatab and Shakak, (2012), which were (1.80 ,1.83 0.59 and 1.00 meq O_2 kg oil) respectively. The free fatty acid as oleic acid was calculated, the result obtained was 1.40% which was higher than those reported by Salah, (2006) and Khatab and Shakak, (2012) they were 1.12 and 0.282, respectively.

Table 1: Oil content and physical properties of moringa seed oil

Parameters	Mean value
Oil content	38.6%
Refractive index	1.4640
Density	0.9190
Viscosity	20.22 cp
Colour	
Red	5.0
Yellow	1.3
Blue	0.00

Each value is mean of three determination

Table 2: Chemical properties of moringa seed oil

Parameters	Mean value
Peroxide value (P.V)	2.79± 2Δ
Free fatty acid (F.F. A)	1.40± 2Δ

Each value is mean of three determinations

3- Fatty acids composition of moringa seed oil

Table 3 shows the fatty acids composition of moringa seed oil. The percentage of unsaturated fatty acid was 87.52% which was higher than value 80.78% reported by Khatab and Shakak, (2012), it means that oil of moringa seed was high stable for use in food cooking and deep frying because it contain high percentage of unsaturated fatty acid (oleic acid),The result showed oleic acid 45.09 which was lower than value 57.00 reported by Khatab and Shakak, (2012), but value of linoleic acid 42.43% was higher than 13.28% reported by Khatab and Shakak, (2012), value of Stearic acid 8.38% was near to 8.93% reported by Khatab and Shakak, (2012). Palmatic acid 0.52% was lower than 8.18% which was reported by Khatab and Shakak, (2012).

Table 3: Fatty acids composition of Moringa seed oil :

Fatty acids	%
Oleic acid	45.09
Linoleic acid	42.43
Stearic acid	8.38
behenic acid	1.77
Palmatic acid	0.52
Others	1.81

4- Effect of frying process on physical properties of moringa, sunflower, cottonseed and groundnut oils

Table 4 shows that there were no significant difference ((P≥0.05)) between first frying and second frying in refractive index of moringa, sunflower, cottonseed and groundnut oils, which were 1.469 1.475, 1.465 and 1.467, respectively but there was significant difference (p≤ 0.05) between third frying of moringa, sunflower, cottonseed and groundnut oils which were 1.471, 1.476, 1.476 and 1.479, respectively. These results in refractive index of moringa and groundnut before frying (control) and after first frying 1.4640, 1.469, 1.4667, 1.478 respectively were completely disagreed with those reported by Khatab and Shakak, (2012), which were 1.485 , 1.471 , 1.470, respectively.

There were no significant differences between first frying and second frying in viscosity of moringa, sunflower, cottonseed and groundnut oils which were 20.21, 15.27, 15.23 and 18.95) cp respectively, when they were compared to the control

there were significant differences between the second and the third frying of moringa , sunflower , cottonseed and groundnut oils which were (21.25 , 17.39 , 17.23 , and 20-36) cp respectively. Also there were significant differences between the first and the second frying of density of moringa, sunflower, cottonseed and groundnut oils which were (0.9103, 0.9168, 0.9155 and 0.9136) respectively, but there was no significant difference between the second and the third frying of sunflower oil which was 0.9176 .

There were significant differences of red colour between the third frying of moringa, sunflower, cottonseed and groundnut oils; which were 6.5, 1.4, 34 and 37 respectively, there was no significant difference of the red colour between sunflower oil before frying and after frying which was 1.40, but there were significant differences in yellow colour of sunflower before frying and after first frying, second frying and third frying 1.50 , 0.5, 0.6, 0.7, respectively, there were significant differences of red colour of moringa oil between the control and after first and second frying 5.00 , 6.00, 6.50, respectively, but there were no significant differences of red colour between cottonseed and groundnut oils after second and third frying 34.00, 37.00 respectively. For cottonseed oil there were no significant differences of yellow colour between first, second and third frying 1.70 but there were significant differences of yellow colour between groundnut oil before frying and first, second and third frying 1.30, 1.50, 2.10, 2.30, respectively; also they were significant differences in blue colour of groundnut oil (control) first and second frying 0.3, 0.2, 0.1 respectively but there was no significant difference in sunflower oil which was 1.40, Yellow colour there were significant differences between second and third frying of moringa, and groundnut oils which 1.60, 2.00, 2.10, 2.30 respectively, but no significant difference was noticed between second and third frying of sunflower

and cottonseeds oils which were 0.70 and 1.70, respectively . There were significant differences in blue colour of first, second and third frying of groundnut oil which 0.30, 0.20 and 0.10, respectively.

5- Effect of frying on chemical properties of moringa, sunflower, cottonseed and groundnut oils

Table 5 shows that there were no significant difference of free fatty acids of moringa and groundnut oils before frying (control) and after first frying and the second frying which were 1.40, 1.40, 1.82, 1.39, 1.03 1.81%) respectively and these results were disagreed with those of moringa and groundnut oils reported by Khatab and Shakak, (2012) which were 0.282 and 0.564% respectively. This difference may be due to storage and mishandling of oil seeds, also the result indicated that there was no significant difference between free fatty acids of sunflower before frying (control) and first frying and second frying which were (0.28, 0.41, 0.42)%) respectively but there was significant difference between them and third frying (0.98%). there was no significant difference of free fatty acids of cottonseed oil (control) and after first, second and third frying which were (0.3 , 0.56 , 0.284, 0.98%), respectively. Also there was significant difference between free fatty acids of third frying of moringa, sunflower, cottonseed and groundnut oils which were (3.74, 0.98, 0.98, 1.81)%), respectively.

ISSN: 2455-7668

Table 4: Changes in physical properties of some vegetable oils during frying process

Oils	Refractive index				Viscosity (c.p)				Density				Colour											
													Red				Yellow				Blue			
	Frying																							
	Cont.	1st	2nd	3rd	Cont	1st	2nd	3rd	Cont	1st	2nd	3rd	Cont	1st	2nd	3rd	Cont	1st	2nd	3rd	Cont	1st	2nd	3rd
Moringa	1.464 ±0.01^{k}	1.469 ±0.02^{g}	1.469 ±0.02^{g}	1.471 ±0.02^{f}	20.22 ±0.00^{abc}	20.21 ±0.00^{abc}	20.51 ±0.00^{ab}	21.25 ±0.00^{a}	0.9190 ±0.00^{i}	0.9103 ±0.00^{h}	0.9123 ±0.00^{g}	0.9140 ±0.00^{f}	5.00 ±0.02^{i}	6.00 ±0.03^{h}	6.50 ±0.04^{g}	6.50 ±0.04^{g}	1.30 ±0.01^{h}	1.50 ±0.02^{f}	1.60 ±0.03^{e}	2.00 ±0.05^{c}	0.00 ±0.00^{d}	0.00 ±0.00^{d}	0.00 ±0.00^{d}	0.00 ±0.00^{d}
Sunflower	1.474 ±0.03^{e}	1.475 ±0.03^{d}	1.475 ±0.03^{d}	1.476 ±0.04^{c}	15.12 ±0.00^{f}	15.27 ±0.00^{f}	16.12 ±0.00^{ef}	17.39 ±0.00^{de}	0.9151 ±0.00^{e}	0.9168 ±0.00^{d}	0.9176 ±0.00^{c}	0.9176 ±0.00^{c}	1.40 ±0.01^{j}	1.40 ±0.01^{j}	1.40 ±0.01^{j}	1.40 ±0.01^{j}	1.50 ±0.02^{f}	0.50 ±0.00^{k}	0.60 ±0.00^{j}	0.70 ±0.00^{i}	0.00 ±0.00^{d}	0.00 ±0.00^{d}	0.00 ±0.00^{d}	0.00 ±0.00^{d}
Cottonseed	1.464 ±0.00^{l}	1.465 ±0.00^{j}	1.475 ±0.03^{e}	1.476 ±0.04^{d}	15.19 ±0.00^{f}	15.33 ±0.00^{f}	16.97 ±0.00^{e}	17.23 ±0.00^{e}	0.9140 ±0.00^{f}	0.9155 ±0.00^{e}	0.9212 ±0.00^{b}	0.9235 ±0.00^{a}	20.00 ±0.14^{d}	25.10 ±0.18^{c}	34.00 ±0.25^{b}	34.00 ±0.25^{b}	1.40 ±0.01^{g}	1.70 ±0.04^{d}	1.70 ±0.04^{d}	1.70 ±0.04^{d}	0.00 ±0.00^{d}	0.00 ±0.00^{d}	0.00 ±0.00^{d}	0.00 ±0.00^{d}
Groundnut	1.466 ±0.01^{i}	1.467 ±0.01^{h}	1.478 ±0.05^{b}	1.479 ±0.05^{a}	18.73 ±0.00^{cd}	18.95 ±0.00^{bc}	19.37 ±0.00^{bc}	20.36 ±0.00^{ab}	0.9125 ±0.00^{g}	0.9136 ±0.00^{f}	0.9157 ±0.00^{e}	0.9179 ±0.00^{c}	7.20 ±0.08^{f}	17.00 ±0.11^{e}	37.00 ±0.28^{a}	37.00 ±0.28^{a}	1.30 ±0.01^{h}	1.50 ±0.02^{f}	2.10 ±0.05^{b}	2.30 ±0.06^{a}	0.30 ±0.00^{a}	0.20 ±0.00^{b}	0.10 ±0.00^{c}	0.00 ±0.00^{d}
$Lsd_{0.05}$	0.0007*				1.411*				0.0007*				0.0007*				0.0007*				0.0007*			
Lsd±	0.0002				0.4706				0.0002				0.0002				0.0002				0.0002			

Mean values having different superscripts letters within columns and rows differ significantly (P≤0.05).

Also table 5 indicated that there was significant difference between peroxide values of moringa and groundnut oils before frying (control) and after first frying which were (3.48, 4.96, 6.00, 9.45) meqO_2/Kg respectively, these values were disagreed with Khatab and Shakak (2012) which were (1.00, 7.00) meqO_2/Kg before frying and after frying respectively. This difference might be related to season, storage and/or mishandling of oils or seeds. Also the result showed that there was no significant difference between first frying and second frying in peroxide values of moringa oil which were (3.48, 4.96) meqO_2/ Kg, respectively. It indicated that the oil of Moringa was more stable compared to other oils (groundnut, cottonseed and sunflower) during first frying and second frying (4.45, 10.47, 11.4, 11.47, 10.98, 11.44) meqO_2/Kg, respectively. also the same thing was true about peroxide value of Moringa oil (7.25) and the other oils (sunflower, cottonseeds and groundnut) during third frying, which were (11.97 , 11.98 , 14.48) meqO_2/Kg, respectively.

6- Acceptability of potato fried with Moringa, sunflower, cottonseed and groundnut oils

Table 6 shows sensory evaluation (taste, flavour, colour, texture and acceptability of fried potatoes by different oils. There was no significant difference noticed between taste of potato chips fried with moringa oil during first, second and third time 2.57, 2.43 and 2.64 respectively. Also there was no significant difference between taste of potato chips fried with sunflower oil during first and third times 2.21 and 1.93, respectively. But there was significant difference between the taste of fried potato chips with groundnut oil during first, second and third frying 1.50, 1.79 and 2.00, respectively. Also there was significant difference between potato chips taste fried with moringa oil and those fried with others (sunflower, cottonseeds and groundnut oils).

There was significant difference between flavour of potato chips fried with all types of oils (moringa, sunflower seed, cottonseed and groundnut) oils for first,

second and third frying time (2.46 2.86, 2.7); (2.21, 3.07,1.93); (1.79, 2.00, 1.86) and (2.64,2.86, 2.71) respectively,

There was no significant difference between potato chips colour fried with moringa seed oil for first, second and third frying period (3.07, 3.50 and 3.14) respectively. But there were significant differences between the colours of all potato chips fried with different oils (sunflower, cottonseed and groundnut oils) after first, second and third frying time as (2.71, 2.86, 2.21); (2.57, 3.14, 2.29) and (1.64, 2.00, 2.07) respectively.

There was no significant difference between potato chips texture fried with moringa seed and cottonseed oils after first frying and second frying period (2.86, 3.00, 2.71 2.79) respectively, while there was significant difference between the texture of those products fried with sunflower and groundnut oils after first frying and second frying time (2.57, 2.93, 1.93, 2.14) respectively. It's noticed that there was no significant change of potato chips texture that fried with cottonseed oil even after the third frying period.

There was no significant difference between all acceptability of potato chips produced with moringa seed, sunflower seed and cottonseed oils after first frying and third frying period (2.71, 2.93 2.71, 3.07, 2.43 and 2.43) respectively; but there was significant change between total acceptability of potato chips fried with groundnut oil after first frying second frying and third frying periods (1.64, 1.78, 2.21) respectively.

Table 5: Changes in chemical properties of some vegetable oils during frying process

Oils	Free fatty acids (%)				Peroxide value (mEq/kg)			
	Frying				Frying			
	Before frying (control)	1st	2nd	3rd	Before frying (control)	1st	2nd	3rd
Moringa	1.40±0.01^{bc}	1.40±0.00^{bc}	1.82±0.21^{bc}	3.74±0.50^{a}	2.97±0.00^{f}	3.48±0.69^{ef}	4.96d±0.01^{ef}	7.25±1.07^{cd}
Sunflower	0.28±0.00^{c}	0.41±0.01^{c}	0.42±0.00^{c}	0.98±0.20^{bc}	7.46±0.69^{cd}	11.44±0.72^{b}	10.98±1.41^{b}	11.97±1.36^{ab}
Cottonseed	0.30±0.03^{c}	0.56±0.00^{bc}	0.84±0.00^{bc}	0.98±0.20^{bc}	9.48±0.72^{bc}	11.41±2.08^{b}	11.47±0.68^{b}	11.98±1.43^{ab}
Groundnut	1.39±0.01^{bc}	1.03±0.34^{bc}	2.25±0.40^{ab}	1.81±0.24^{bc}	6.00±0.83^{de}	9.45±0.71^{bc}	10.47±0.66^{b}	14.48±0.71^{a}
$Lsd_{0.05}$	1.537*				2.556*			
Lsd±	0.5128				0.8526			

MeanSD values having different superscripts within columns and rows are differ significantly (P≤0.05)

Also there was significant difference potato chips all acceptability parameters of the oils after third frying in moringa, sunflower , cottonseed and groundnut oils (2.93, 2.14, 2.43 and 2.21,) respectively.

Table 6: Acceptability of fried potatoes by different oils

Oils	No. of FryingProcess			$Lsd_{0.05}$	SE±
	1st	2nd	3rd		
Taste					
Moringa	2.57±0.93^{ab}	2.43±0.91^{ab}	2.64±0.97^{ab}	0.7466*	0.2673
Sunflower	2.21±1.05^{abc}	2.79±0.97^{a}	1.93±0.92^{abc}		
Cottonseed	2.36±0.65^{abc}	2.29±0.70^{abc}	1.79±1.04^{bc}		
Groundnut	1.50±1.28^{c}	1.79±1.22^{bc}	2.00±1.15^{abc}		
Flavour					
Moringa	2.64±0.84^{abcd}	2.86±0.91^{ab}	2.71±0.83^{abc}	0.7165*	0.2565
Sunflower	2.21±1.05^{bcdef}	3.07±0.73^{a}	1.50±0.52^{f}		
Cottonseed	2.36±0.80^{abcde}	2.29±0.78^{abcdef}	1.93±0.86^{cdef}		
Groundnut	1.79±1.45^{ef}	2.00±1.10^{cdef}	1.86±1.27^{def}		
Colour					
Moringa	3.07±0.94^{abc}	3.50±1.03^{a}	3.14±1.33^{ab}	0.7204*	0.2579
Sunflower	2.71±0.99^{abcde}	2.86±0.77^{abcd}	2.21±0.80^{def}		
Cottonseed	2.57±0.63^{bcde}	3.14±0.96^{ab}	2.29±1.07^{cdef}		
Groundnut	1.64±1.27^{f}	2.00±0.65^{ef}	2.07±0.86^{def}		
Texture					
Moringa	2.86±0.99^{a}	3.00±0.97^{a}	2.64±1.16^{ab}	0.765*	0.2739
Sunflower	2.57±1.09^{ab}	2.93±0.92^{a}	2.14±0.53^{ab}		
Cottonseed	2.71±0.92^{ab}	2.79±0.86^{ab}	2.43±1.02^{ab}		
Groundnut	1.93±1.46^{b}	2.14±0.88^{ab}	2.50±1.22^{ab}		
Acceptability					
Moringa	2.71±0.94^{ab}	3.07±0.74^{a}	2.93±1.28^{ab}	0.7518*	0.2691
Sunflower	2.71±0.91^{ab}	3.07±1.00^{a}	2.14±0.66^{bc}		
Cottonseed	2.43±0.74^{abc}	2.36±0.80^{abc}	2.43±1.05^{abc}		
Groundnut	1.64±1.44^{c}	1.78±0.73^{c}	2.21±1.38^{abc}		

MeanSD values having different superscripts betters within columns and rows differ significantly ($P \leq 0.05$).

Conclusions

This study concluded that physicochemical composition of moringa seed oil was in range of vegetable oils, the oil proved to be good for frying and cooking when compared with other vegetable oils available in Sudan.

Recommendations

More studies about this tree and oil are needed.

Reference

1-A.O.C.S. (2006). Official Methods and Recommended Practices of the American Oil Chemists Society 4th edn, edited by AOCS, Champaign, IL Official Method, Cd, 3- 25 reapproved (2006)

2-Anwar, F and Rashid,U.(2007). Physicochemical characteristics of Moringa oleifera seeds and seed oil from a wild provenance of Pakistan Pakistan Journal botany ,39(5) :1443-1453.

3-AOAC. (2010). Official Methods of Analysis, Association of Official Analytical Chemists, Washington D.C. (17th ed)

4-Fuglie, L.J. (1999). The Miracle tree: *Moringa oleifera*. Natural Nutrition for the Tropic . Church World Service, Dakar 68 pp; revised in 2001 and published as the Miracle Tree: The Multiple Attributes of Moringa , 172pp .

5- Ibrahim, Z. H. (2000). Effect of frequent frying and storage changes on the quality of watermelon seed oil compared to cottonseed oil. M. Sc. Thesis, Faculty of Agricultural Studies, Sudan University, Khartoum, Sudan.

6-Jahan, S.A.A.(1986). Proper Use of African natural coagulants for rural water supplies. Research in Sudan and a guide to new projects .GTZ manural No

7-Khatab M. A. and Shakak M. A. S. (2012). Effect of Frying on the Physicochemical Properties of *Moringa oleifera*, Groundnut (*Arachis hypogaea*) Oil and their Blends. Journal of Science and Technology, Vol.13. JAVS No. 2. SUST Sudan. http://journals.sustech.edu

8-Lalas, S. and Tsaknis J. (2002). Chariz of *Moringa oliefera* . Seed oil Variety Peri yakulam ─1 Journal of food composition and Analysis . 15:65─77.

9-Mattson, F.H. And Grundy, S.M. (1985). Comparison of Effect of Dietary Saturated, Monounsaturated and Poly Unsaturated Fatty acids on Plasma Lipids and lipoprotein In: man lipids Research 26: 194 – 202

10-Mensink ,R.P. and Katan.M.B.J.(1990). Effect of Dietary Trans –fatty Acids on High -Density and Low Density Lipoprotein Cholesterol Levels in Healthy Subject .Journal of Clinical Nutrition 323:439-445.

11-Morton, J.F. (1991). The Horseradish tree , Moringa pterygosperma (Moringaceae).a boon to aird lands ? EconomicBotany.45:318-333

12- Mostafa, M.M., Rady, A.H., Faried, A. and El-Egieul (1996). Blending of palm olein with cottonseed oil. Food Science and Tech. Dept., Faculty of Agriculture, Minufiya University, Shebin El-kom, Egypt.

13-NRC (2006) National Research Council." Moringa" Last Crops of Africa Volume 11: Vegetable. Page 246-267.

14-Salah R.M .(2006) . Physiochemical properties of oil extracted from Moringa (Moringa oleifera) seeds , M.Sc , Thesis , University of Khartoum . Sudan .

15-Sengupta,A. and Gupta ,M.p(1970). Studies on the Seed Fat Composition of Moringaceace Family. Fette, seifen, Anstrichm 72:6-10

16-Shakak M. A., Rahama A. A. and Elfaki A. E. (2015). Stability of some edible oil blends based on palm olein. Journal of Agricultural and Veterinary Sciences (SJAVS), Vol. 16 No. (1), P.93 – 102. http://journals.sustech.edu

17-Tsaknis,J.Lalas,S.,Gergis,V., **Dourtoglou, V.and Spiliotis ,V,(1999),**Characterization of *Moringa Oleifera* variety Mbololo seed oil seed of Kenya J:Agric food chem.,47:4495-4499.