Effect of Frying on the Physicochemical Properties of *Moringa oleifera*, Groundnut (*Arachis hypogaea*) Ail and their Blends

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Abstract: This study was conducted to study quality of Moringa oil and his suitability for frying, Samples of Moringa seeds were collected from Aldamazin, subjected for the proximate analysis of seeds and physicochemical analysis and frying quality of oil. The results obtained showed that there were significant difference ($P \leq 0.05$) in density and refractive index for Moringa oil, groundnut oil and their blend before frying. There was no significant difference in the viscosity between Moringa oil and groundnut oil before frying, while a significant difference was showed in the viscosity between Moringa oil and the blend before frying. The results showed significant difference in density, viscosity and refractive index after frying between Moringa oil and groundnut oil. There was a significant difference in viscosity and refractive index after frying between Moringa oil and the blend, while there was no significant difference was noticed in the density after frying between Moringa oil and the blend The results showed that there was significant difference in peroxide value for Moringa oil compared with groundnut oil and their blend before frying and after frying, while there was no significant difference in peroxide value for Moringa oil, groundnut oil and their blend before frying compared to after frying . There was significant difference in free fatty acids for Moringa oil compared with groundnut oil and their blend before frying and after frying, while there was no significant difference of F. F. A for Moringa oil, groundnut oil and their blend before frying compared to after frying. The results obtained showed that there was significant difference in the taste, colour and acceptability for potato chips fried in Moringa oil, groundnut oil and their blend, also no significant difference in odour and texture for potato chips fried in Moringa oil compared with groundnut oil, while a significant difference in odour and texture for potato chips fried in Moringa oil compared with the blend.

Keywords: Physical properties, Chemical properties, Fatty acids composition, Proximate analysis, Moringa seeds

Introduction

Moringa is considered one of the world trees most useful as almost every part of the Moringa tree can be used for food, or has some other beneficial property. In the tropics it is used as forage for livestock, and Moringa 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 of alum by rural women to treat highly turbid Nile water (Jahn, 1986).

A large number of reports on the nutritional qualities of Moringa now exist in both the scientific and the popular literature. It is commonly said that Moringa leaves contain more vitamin A than carrots, more calcium than milk, more iron than spinach, more vitamin C than oranges, and more potassium than bananas, and that the protein quality of Moringa leaves rivals that of milk and eggs (Fuglie, 2000).. However, the leaves and stem of *Moringa oleifera* are known to have large amounts of their calcium bound in calcium oxalate crystals (Olson and Carlquist, 2001).

The seed oil contains all the fatty acids contained in olive oil, except linoleic and was

used as its acceptable substitute (Morton, 1991). The seeds contain between 33 and 41% w/w of vegetable oil (Sengupta and Gupta, 1970). The oil is rich in oleic acid (>70%). Oils that are high in mono-unsatu-rated/oleic acid can be used as a healthier alternative to the more saturated and hydro-genated oils used in frying because of their stability. Consumption of saturated and parti-ally hydrogenated fats and oils has been shown to increase the risk of coronary heart disease (Mattson and Grundy, 1985; Mensink and Katan, 1990).

Moringa oleifera is commercially known as ‘‘ben oil” or ‘‘behen oil”, due to its content of behanic acid, possesses significant resistance to oxidative degradation (Lalas and Tsaknis, 2002). Moringa 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 during storage and also burns without smoke (Fuglie, 1999).

The objectives of the study were to study the physicochemical properties of Moringa oil, test the frying stability and quality of Moringa oil and to study the blend of Moringa oil with groundnut oil for frying process.

Materials and Methods

The seeds were collected from Al Damazin; groundnut oil brought from local market. Sample of Moringa seeds were cleaned by removing foreign particles .Then kept in polyethylene bags for further analysis away from light at room temperature.

Moisture content, refractive index (RI),oil density , peroxide value (PV) ,free fatty acids (FFA) , iodine value , saponification value, oil content, protein content, crude fiber, and ash content were determined according to the AOAC method (2000).Viscosity of the oil samples was determined using an Ostwald-U-tube viscometer according to (Cocks and Rede,1966). The extraction of the oil from Moringa seeds was done in the manner described by Balla (2001). About one kilo-gram seeds were weighed after removal of impurities, using mortar the size of the seeds was reduced to increase the surface area for oil extraction. The sample was transferred to cloth bag, and then the oil was extracted from the seeds using cold press.

The colour intensity of oils was determined using a Lovibond Tintometer as units of red, yellow and blue) in the manner described by Balla (2001). Fatty acid composition of oil was determined by gas chromatography apparatus (Py E-UNICAM model GCD). (ACMLT, 1990). Moringa oil was blended with groundnut oil in a 1:1 ratio; the blend was well shaken and then used for frying potatoes. Deep frying operation were carried out in tefal fryer, 2 Kg of potato were used for frying. Potatoes were cut to slices and were divided to 3 parts, every part fried in 1/2 pound of groundnut oil, Moringa oil and their blend for 15 minutes, thermostat control was used for measuring the frying temperature at 160 °C, Sample was cooled and stored until required for analysis.

Fried potatoes were assessed organoleptically by the ranking test according to the procedure described by Ihekoronye and Ngoddy (1985). Trained17panelist from Food Research Cen-tre staff were asked to evaluate taste, colour, odour, texture and acceptability.

The ranking test depended on the range (a) as very good, (b) as good and (c) as bad.

The analysis of results were performed the means of SAS using Duncan's multiple range test (DMRT) Steel *et al* (1997).

Results and Discussion

Table (1) shows the proximate analysis of moringa seeds which includes: moisture, oil, protein, crude fiber, carbohydrates and ash contents. The moisture content of Moringa seeds was 4.55 %. This percentage is slightly lower than the values 5.70% and 5.5% reported by Anwar and Rashid (2007) and Salah (2006) respectively.

Moringa seeds had an oil content of 43.79%, which was higher than (25.1%, 38.3% and

41.4%), 40.39% and 39.1% .reported by Lalas and Tsaknis (2002), Anwar and Rashid (2007), and Salah (2006) respectively.

The protein content of Moringa seeds was 41.13%. This value was lower than that reported by Salah (2006) , however higher than that percentage reported by Anwar and Rashid (2007).

The crude fiber content of *Moringa* seeds was 4.40%, this value was lower than the value of 7.54% reported by Anwar and Rashid (2007), and higher than the value of 1.2% reported by Salah (2006) for crude fiber content of Moringa seeds.

The ash content of Moringa seeds was 3.36%, this value was slightly lower than 3.6% reported by Salah (2006), and 6.60% reported by Anwar and Rashid (2007).

Table (1) proximate analysis of moringa seeds

Constituent	Current study content%	Anwar and Rashed (2007)	Salah (2006)
Moisture content	4.55	5.70	5.50
Oil content	43.79	25.1,38.3,41.4	39.1
Protein content	41.13	47.2	29.36
Crude fiber	4.40	7.54	1.2
*Carbohydrates	2.77	-	-
Ash content	3.36	6.6	3.6

*Calculated by difference **:** Each value is mean of three determination

The Physical properties of Moringa oil

Table (2) shows that the physical properties of Moringa oil, which covers: refractive index, viscosity and density and colour range is shown in Table (3). The refractive index of Moringa oil was 1.4850 compared to 1.4640 which was reported by Salah (2006), also this value was higher than the of value 1.4549 reported by Tsaknis *et al.,* (1999), Anwar and Rashid (2007) reported that the refractive index of Moringa oil was 1.4608, lower than the value obtained in this study. The density of Moringa oil was 0.8999 .This value was lower than 0.9469 reported by Salah (2006). Also it was lower than the value obtained by Lalas and Tsaknis (2002) who found density Moringa oil was 0.909 at 24 °C mg/mL ,While it was slightly higher than 0.8809 reported by Tsaknis *et al.,* (1999).

The viscosity of Moringa seeds oil was 35.6 cp. It was observed that the Moringa oil viscosity value was lower than that reported by Tsaknis *et al.,* (1999) 57cp. Also it was lower than 45.5 cp reported by Lalas and Tsaknis (2002) and 45.82 cp reported by Salah (2006).

Tintometer readings for colour of Moringa oil was 4.0, 0.1 and 0.0 for yellow, red and blue colour, respectively. These values were lower han the values reported by Anwar and Rashid

(2007) for yellow colour who obtained 7.12 and it was the same value for red colour, while it was higher than
value reported by Lalas and Tsaknis (2002) which is 3.14 for yellow colour and lower than value for red colour (0.2) for Moringa oil extracted by hexane compared with colour of Moringa oil extracted by cold press is 0.10 for red colour and 2.4 for yellow unit. Also it was lower than value of 6.3 for yellow colour and 1.5 for red colour reported by Salah (2006).

Table 2. Physical properties of Moringa oil

Parameter	Mean value
Refractive index	1.4850
Density	0.8999
Viscosity (cp)	35.60

* Each value is mean of three determinations

. Table (3) Colour range of fried potato slices using Moringa oil.

Colour	Mean value
Red	0.1
Yellow	4.0
Blue	0.0

*Each value is mean of three determinations

The Chemica properties of Moringa oil

The results of free fatty acids (FFA), saponification, iodine and peroxide values of Moringa oil are shown on Table (4).
Moringa oil read FFA of 0.282 %, which was lower than 1.128 reported by Salah (2006). (2002) and Salah (2006) respectively, Always higher saponification values indicate shorter chain of fatty acids. The iodine value of Moringa oil, as Iodine /100g oil, was 51.9 this While Anwar and Rashid (2007) reported the Iodine value of Moringa oil 69.45. Lalas and Tsaknis (2002) The iodine value of Moringa oil extracted by hexane and cold press was

The saponification value of Moringa oil in our study (Table 4), was higher than 178.11 reported by Tsaknis *et al.,* (1999) .While it was lower than 186.67, 188.36 and182 reported by Anwar and Rashid, (2007) , Lalas and Tsaknis, value was lower than all values reported by some investigation. Tsaknis *et al.,* (1999) reported the Iodine value of Moringa oil 66.83.

65.58 and 65.73 respectively (Lalas and Tsaknis, 2002). Also Salah (2006) found that the Iodine value of Moringa oil was 88. The peroxide value of Moringa oil was found to be

1.0(meq O2/ kg of oil). This value was higher than 0.59 (meq O2 / kg oil) reported by Anwar and Rashid (2007), while it was lower than 1.83 (meq O2/ kg oil) of Moringa oil extracted by hexane compared with peroxide value of Moringa oil extracted by cold press which was 0.11 (meq O2/ kg of oil) reported by Lalas and Tsaknis (2002). Also it was lower than 1.80 (meq O2/ kg of oil) for peroxide value of Moringa oil extracted by hexane reported by Tsaknis *et al* (1999). Salah (2006) found that the peroxide value of Moringa oil was 9 (meq O2/ kg of oil), this value was higher than the value in this study.

Fatty acids profile of Moringa oil Table (5) shows the fatty acid profile of Moringa oil. The percentage of unsaturated fatty acids was 80.78% which was higher than 76% reported by Sonntag (1982). The percentage of palmitic acid was 8.18% which was higher than 6.40% reported by Tsaknis *et al* (1999). This means the Moringa oil is stable to food cooking and deep frying process because it contains high percentage of monounsaturated fatty acid (oleic acid). Gunstone and Hilditch (1945) reported that the relative rates of auto-oxidation of methyl oleate, linoleate and linoenate were in the order of 1:12:25. Clegg (1973) also reported that the relative rate of oxidation for oleic, linoleic and linoleic acids are 1, 15 and 30 respectively.

Effect of frying process on physical properties of oils.

The effect of frying process on physical properties for Moringa oil, groundnut oil and their blend was shown in table (6). there was a significant difference ($P \leq 0.05$) between the density of Moringa oil 0.8999; groundnut oil 0.9082 and their blend 0.9058 before frying, also a significant difference ($P \leq 0.05$) between the density after frying of Moringa oil 0.9223 compared with groundnut oil 0.9249, while there was no significant difference ($P \geq 0.05$) observed between the density of Moringa oil 0.9223 and the blend 0.9228 after frying. Also a significant difference ($P \leq 0.05$) was found between the density of Moringa oil; groundnut oil and their blend before frying compared with after frying. There was no significant difference ($P \geq 0.05$) observed between the viscosity of Moringa oil 35.6 cp and groundnut oil 36.2 cp before frying, while there was a significant difference ($P \leq 0.05$) between the viscosity of Moringa oil 35.6 cp and the blend 33.4 cp before frying, also there was a significant difference of viscosity after frying ($P \leq 0.05$) observed between Moringa oil 39.7 cp compared with groundnut oil 42.2 cp and their blend 35.9 cp.A significant difference in viscosity ($P \leq 0.05$) was observed between Moringa oil; groundnut oil and their blend before frying compared with after frying. Table (6) shows a significant difference ($P \leq 0.05$) between the Refractive Index of Moringa oil 1.485 compared with groundnut oil 1.471 and their blend 1.472 before frying, also a significant difference ($P \leq 0.05$) was observed between the Refractive Index of Moringa oil 1.485 compared with groundnut oil 1.470 and their blend 1.470 after frying. A significant difference ($P \leq 0.05$) was found between the Refractive Index of groundnut oil and the blend before frying compared with after frying, while no significant difference ($P \geq 0.05$) was observed between the Refractive Index of Moringa oil before frying compared with after frying.

Table (4) Chemical properties of Moringa Oil

Parameter	Mean value
Peroxide value	1.00
Free fatty acid	0.282
Saponification value	180.90
Iodine value	51.90

*Each value is mean of three determinations

Table (5) Fatty acids composition of Moringa oil

Fatty acid	%
Oleic acid	57.00
Eicosapentaenoic acid (Omega 3 acid)	13.28
Arachedonic acid	10.50
Stearic acid	8.93
Palmatic acid	8.18
Other acids	2.11

Table (6): Effect of frying on the physical properties of Moringa oil, groundnut oil and their blend

Type of oil	Mean of Physical properties					
	Density		Viscosity		Refractive index	
	Frying					
	Before	After	Before	After	Before	After
Groundnut oil	$0.9082^{c} \pm 0.00$	$0.9249^{a} \pm 0.00$	$36.2^{c} \pm 0.49$	$42.2^{a} \pm 0.22$	$1.471^{c} \pm 0.00$	$1.470^{d} \pm 0.00$
Moringa oil	$0.8999^{e} \pm 0.00$	$0.9223^{b} \pm 0.00$	$35.6^{c} \pm 0.54$	$39.7^{b} \pm 0.31$	$1.485^{a} \pm 0.00$	$1.485^{a} \pm 0.00$
The blend	$0.9058^{d} \pm 0.00$	$0.9228^{b} \pm 0.00$	$33.4^{d} \pm 0.51$	$35.9^{c} \pm 0.20$	$1.472^{b} \pm 0.00$	$1.470^{d} \pm 0.00$

Mean values having different superscript letter(s) in columns and rows differ significantly ($P \leq 0.05$)

The Effect of frying process on chemical properties of oils

Table (7) shows The effect of frying process on chemical properties (FFA and PV) of Moringa oil, groundnut oil and their blend. there was significant difference ($P \leq 0.05$) in free fatty acids for Moringa oil 0.282 compared with groundnut oil 0.564 and their blend 0.564 before frying and after frying, while there was no significant difference ($P \geq 0.05$) of F.F.A for Moringa oil, groundnut oil and their blend before frying compared to after frying.

There was significant difference ($P \leq 0.05$) in the peroxide value for Moringa oil 1.00 compared with groundnut oil 7.00 and their blend 6.00 before frying and also after frying, while there was no significant difference ($P \geq 0.05$) of the peroxide value for Moringa oil, groundnut oil and their blend before frying compared to after frying .

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Table (7): Effect of frying process on chemical properties of Moringa oil, groundnut oil and their blend

	Mean of Chemical properties			
	Peroxide value		Free fatty acids	
	Frying			
Type of oil	Before	After	Before	After
Groundnut oil	7.00 ^{a} ±0.00	7.00 ^{a} ±0.00	0.564 ^{a} ±0.00	0.564 ^{a} ±0.00
Moringa oil	1.00 ^{c} ±0.00	1.00 ^{c} ±0.00	0.282 ^{b} ±0.00	0.282 ^{b} ±0.00
The blend	6.00 ^{b} ±0.00	6.00 ^{b} ±0.00	0.564 ^{a} ±0.00	0.564 ^{a} ±0.00

Mean values having different superscript letter(s) in columns and rows differ significantly ($P \leq 0.05$)

Sensory evaluation

Table (8) showed that the taste, the colour and acceptability 33, 33 , 31, respectively of potato chips fried in Moringa oil showed a significant difference ($P \leq 0.05$) compared to potato chips fried in groundnut oil 27, 21, 20, respectively and their blend 42, 47, 43, respectively, but the odour and the texture 29, 32, respectively of potato chips fried in Moringa oil showed no a significant difference ($P \geq 0.05$) compared to that potato chips fried in groundnut oil 28, 28, respectively.

Table (8) also shows that, the odour and texture 29, 32, respectively of potato chips fried in Moringa oil showed a significant difference ($P \leq 0.05$) compared to potato chips fried in their blend 44, 43, respectively.

Table (8): Sensory evaluation of potato fried by Moringa oil, groundnut oil and their blend.

Sample	Taste	Colour	Odour	Texture	Acceptability
Groundnut oil	27^a	21^a	28^b	28^b	20^a
Moringa oil	33^b	33^b	29^b	32^b	31^b
The blend	42^c	47^c	44^c	43^c	43^c

a ≤ 27 , b 27-41 , c ≥ 41

Conclusions and Recommendations

This study indicated that the chemical composition of Moringa oil contained high oil content (43.79%), and this means the seed of Moringa tree is a good source of edible oil. The oil extracted from Mori-nga seeds has good physicochemical properties in such a way that no additional processing operations methods will be needed for the oil. The oil has good quantity of oleic acid and omega3; therefore it can be used for frying and other food purposes. Moringa oil is recomm-ended for frying purposes because it contains high amount of oleic acid (57%) and omega 3 (13.28%).

References

Anwar, F. and Rashid, U. (2007). Physicochemical characteristics of *Moringa Oleifera* seeds and seed oil from a wild provenance of Pakistan . *Pak. J. Bot*. 39(5): 1443-1453.

A.O.A.C **(**2000). "Association of official analysis chemist" Official Methods of Anaysis of The Association Of Official Analytical Chemist. William Horwtiz Editor, 17th ed.

Balla, S.O.A (2001). Studies on the effect of chemical refining on oil quality of three groundnut cultivars grown in sudan. M.Sc.Thesis, University of Kharto-um , Sudan. **4**-Clegg, A. J. (1973) Compa-rison and related nutritional and organo-leptic aspects of palm pil . J. Am. Oil Chem. Soc. 50:321.

Cocks, L.V. and Van Rede**,** C. (1966). Laboratory Handbook for Oil and Fat Analysis. Academic Press, London and New York.

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

Fuglie, L.J. (2000). New Uses of Moringa Studied in Nicaragua. ECHO Development Notes #68, June, 2000.

Ihekoronye, A.I. and Ngoddy, P.O.(1985). Integrated Food Science And Technology For The Tropics. Mac Millan .Pub.,London.

Jahn S. A. A. (1986). Proper use of African natural coagulants for rural water supplies –Research in the Sudan and a guide to new projects. GTZ Manual No. 191.

Lalas, S. and Tsaknis. J. (2002). Characterization of Moringa oleifera seed oil variety Periyakulam-1. J. Food Comp. and Anal.15: 65-77.

Mattson, F.H. and Grundy, S.M. (1985). Comparison of effect of dietary saturated, monounsaturated and polyun-saturated fatty acids on plasma lipids and lipoproteins in man. Lipid Resea-rch. 26: 194-202.

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 subjects. Journal of Clinical Nutrition. 323: 439-445. **13**-Morton, J. F. (1991). The horseradish tree, Moringa pterygo-sperma (Moringaceae) – a boon to arid lands? Economic Botany. **45**: 318–333.

National Research Council (2006) ."Moringa". Lost Crops of Africa Volume II : Vegetables. page: 246-267.

Olson, M.E. and Carlquist, S. (2001). In press. Stem and root anatomical correlations with life form diversity, ecology, and systematics in *Moringa* (Moringaceae). Botanical Journal of the Linnean Society.

Salah, R.M. (2006). Physiochemical Properties of oil extracted from Moringa (*moringa oleifera*) seeds, M.Sc , Thesis, University of Khartoum, Sudan.

Sengupta, A., Gupta, M.P. (1970). Studies on the seed fat composition of Morin-gaceae family. Fette, Seifen, Anstrichm. **72**: 6 – 10.

Sonntag, N. O. V. (1982). In Analytical Methods in Bailey's Industrial Oil and Fat Products, Vol. 2, 4th edn. pp. 440 – 441. John Wiley and Sons, New York.

Steel, R.D.G; Torrie, T.H and Dickey, D. A. (1997). Principles and Procedures of Statistics. A Biometric Approach . 3 rd ed. McGraw-Hill,New York. 666Pp

Tsaknis, J.; Lalas,S.; Gergis, V.; Dourtoglou, V. and Spiliotis, V. (1999). Characterization of *Moringa oleifera* variety Mbololo seed oil of Kenya. *J. Agric. Food Chem.*, **47**: 4495-4499.

أثر القلي على الخواص الفيزيوكيميائية لزيت المورينقا (*Moringa oleifera*) و الفول السوداني (*Arachis hypogaea*) و خليطهما

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المستخلص

أجريت هذه الدراسة لدراسة جودة زيت المورينقا وملائمته للقلي (التحمير). تم جمع بذور المورينقا من منطقه الدمازين ,اخضعت العينة للتحليل التقريبي للبذور,التحاليل الفيزيوكيميائية ومعرفة جودة التحمير للزيت. أوضحت النتائج أن هناك اختلافات معنوية ($P\leq 0.05$) في الخواص الفيزيائية في كل من الكثافة ومعامل الانكسار لزيت المورينقا مقارنة مع زيت الفول السوداني والخليط قبل التحمير, كذلك أوضحت النتائج عدم وجود اختلافات معنوية ($P\geq 0.05$) في اللزوجة بين زيت المورينقا وزيت الفول السوداني قبل التحمير , بينما توجد اختلافات معنوية في اللزوجة بين زيت المورينقا والخليط قبل التحمير.أيضا أوضحت النتائج وجود اختلافات معنوية في الكثافة واللزوجة ومعامل الانكسار بعد التحمير بين زيت المورينقا والفول السوداني ,أيضا أوضحت النتائج وجود اختلافات معنوية في اللزوجة ومعامل الأنكسار بعد التحمير بين زيت المورينقا والخليط , بينما لاتوجد اختلافات معنوية في الكثافة بعد التحمير بين زيت المورينقا والخليط . أوضحت النتائج وجود اختلافات معنوية في الخواص الكيميائية والتي تتضمن قيمة البيروكسيد لزيت المورينقا مقارنه مع زيت الفول السوداني والخليط قبل التحمير وبعد التحمير, كذلك أوضحت النتائج عدم وجود اختلافات معنوية في البيروكسيد لكل من زيت المورينغا ,زيت الفول السوداني والخليط قبل التحمير مقارنة مع بعد التحمير,أيضا أوضحت النتائج وجود اختلافات معنوية في الأحماض الدهنية الحرة لزيت المورينقا مقارنة مع زيت الفول السوداني والخليط قبل التحمير وبعد التحمير, كذلك أوضحت النتائج عدم وجود اختلافات معنوية في الأحماض الدهنية الحرة لكل من زيت المورينقا , زيت الفول السوداني والخليط قبل التحمير مقارنة مع بعد التحمير.أوضحت النتائج وجود اختلافات معنوية في التقييم الحسي الطعم , اللون ، والجودة الكلية للبطاطس المحمرة بزيت المورينقا مقارنة مع الفول السوداني والخليط ,كذلك لا توجد اختلافات معنويه في الرائحة والقوام للبطاطس المحمرة بزيت المورينقا مقارنة مع زيت الفول السوداني , بينما توجد اختلافات معنوية في الرائحه والقوام للبطاطس المحمرة بزيت المورينقا مقارنة مع الخليط.