Banat's University of Agricultural Sciences and Veterinary Medicine from Timisoara,
Department of Exact Sciences,
Contact: web: http://dse.usab-tm.ro, e-mail: secretariat_dse@usab-tm.ro

FATTY ACIDS COMPOSITION AND QUALITY ASSURANCE OF SEMAL (*BOMBAX*) AND MONSA (*CHORISIA*) SEED OILS AND USE IN DEEP-FAT FRYING

Shaker M. Arafat[1], Essam M. Abd El-Kader[2], Sayed R. M. M.[2]

[1]Fats & Oils Department, Food Technology Research Institute, Agriculture Research Center, Giza, Egypt, drshaker_arafat@yahoo.com
[2]Woody Trees and Forestry Research Department. Horticulture Research Institute Agriculture Research Center, Giza, Egypt.

Abstract. This study evaluates the proximate composition of semal (*Bombax*) and monsa (*Chorisia*) seeds, the physico-chemical properties, and fatty acids composition of the seeds oil compared with cotton seed oil. Protein and fat content of semal and monsa seeds were (21.30% and 23.50%) and (28.50 % and 25.15 %), respectively. The major fatty acids components were linoleic (C18:2), Oleic (C18:1) and palmitic (C16:0) in semal and monsa seed oils compared with cotton seed oil. Semal, monsa and cotton seed oils were continuously fried at 180˚C ± 5˚C for 20 hr, 4 hr heating cycle per day for five consecutive days. Aliquots of potato chips were fried in the aforementioned oil samples. Quality assurance testes were performed on non-fried and fried of the oil samples. In generals, the results suggest that semal and monsa seed oil alone and in mixtures with other oil have to ban its use in frying process.

Key words: Bombax seed oil, linoleic acid, chorisia seed oil, frying process.

Introduction

The family *Bombacaceae* consists of about 22 tropical genera and 150 species. The largest genera includes *Bombax* (60 species), Ceiba (15 species), *Durio* (15species), *Salmalia* (10 species) and *Adansonia* (10 species). Some species such as *Bombax ceiba* produces large sized timber of light weight which is used for variety of purposes that is from manufacture of match box and match splint to veneer and plywood. This is very important for the conservation of Asian vultures which is near to extinction. Other commercial products derived from this family include Floss (Kapok) from *Ceiba pentendra,* Floss silk from *Chorisia speciosa* (Monsa) and Silk cotton from *Bombax ceiba* (Semal). In the tropical regions of world, there are about 55 species of Bombacaceae that yields floss similar to Java kapok. [TROUPS, 1981 & NIAZI et al., 2010].

The distribution of *Bombax* tree in Southeast Asia is less well-defined, raging from western India through Malaysia, Indonesia, and Vietnam to Philippines and as far as Samoa and Tahiti. They have different common names in different regions such as kapok and kabu (Javanese), nun (Siamese), *ceiba* P.W.D, white-silk cotton (Latin America) [CHIN & ENOCH 1988 & HOSSAIN et al., 2011]. Seeds have nutritive and calorific values which make them necessary in diets. They are good sources of edible oils and fats. The amount of energy provided by 1 g of fat and oil when fully digested is more than twice as many joules as that by carbohydrates and proteins [ODOEMECLAM, 2005]. Other sources of oil seeds are soybeans, cotton seed groundnut, sunflower, melon, rape seed; benni seeds [FRANK, 1998]. French nut (*Bombax glabrum*) seeds are also high in fat content and could be classified as oil seeds [OLAPOSI & ADUNNI 2010].

Bombax seeds occupy about 25-28 % (wt/wt) of each fruit. The seeds are brownish black in colour, and are 118 imbedded in masses of *kekabu* lint. The seeds contain relatively high crude oil which is about 22-25% by weight and is reported almost identical to edible cotton seeds oil. Hence the *kekabu* seeds oil may be used for the same purposes as cotton seed oil as cooking oil but up till now it is still underutilized.

Linoleic acid, C18:2 n6 (LA) which is rich in cotton seeds oil, is an essential polyunsaturated fatty acid that cannot be synthesized in the human body [AKOH 1998]. LA is the parent or precursor for the omega 6 series of polyunsaturated fatty acids (PUFA) [LENNIE & STEWARD 2001]. The functions of LA include the role in human growth, skin and hair condition and reproduction, and also effective in wound healing. These effects occur largely through the actions of LA in cell membranes [SALIMON & ABD KADIR. 2005]. LA also reduces plasma cholesterol levels, reduces platelet aggregation and serves as a precursor of cell membrane arachidonic acid (AA), which in turn is a substrate for the hormone-like substances known as eicosanoids and leukotrienes. These substances play crucial roles in the regulation of tissue function, cell signaling and in particular gene transcription events [KELLEY & RUDOLPH 2000].

The principal goal of the present paper was to study the chemical composition of semal and monsa seeds, physico-chemical properties and fatty acids composition of the seed oil. Also, use of semal and monsa seed oil in frying process. In addition, quality assurance methods were carried out to evaluate the quality of non-fried and fried semal, monsa and cotton seed oils.

Materials and methods

- ***Source of oils and seeds:*** The seeds of semal and monsa were obtained from Horticulture Research Institute, Giza, Egypt. Refined cotton seed oil was obtained from Sila Edible Oil Company (Kom Osheim), El-Fayoum Governorate, Egypt. The oil peroxide and acid values were (1.2 meq. /kg) and (0.09 KOH/ gm).

- ***Solvents:*** All solvents used throughout the whole work were analytical grade and distilled before use.

- ***Chemical composition of seeds:*** Moisture, ash, fiber, protein, lipid and carbohydrate contents in semal and monsa seeds were determined according **to A.O. A.C (2005).**

Extraction of oil: The decorticated semal and semal seeds were pulverized to a fine powder and extracted with petroleum ether (b.p 40-60˚C) in a soxhlet apparatus for 16 hours. The oil was recovered by evaporating the petroleum ether on a rotary evaporator under reduced pressure.

- ***Quality assurance testes:*** Refractive index, acid value and peroxide value were determined according to **A.O. A.C. (2005)**. Smoke point refers to the temperature at which the oil sample begins to smoke and is recorded as out lined by **Nielsen (1998).**A Lovibond tintometer apparatus (The Tintometer Ltd., Salisbry, England was applied to measure the color of non-fried and fried oil samples. The yellow glass slides were fixed at 35 and the intensity of red glasses was assigned through matching with the oil samples **Nielsen (1998)**. The relative flow times of the different oil samples were measured using an Ostwald Viscometer (Brookfield Engineering Laboratories. Inc., Stoughon, MA, USA) according to **Joslyin (1950**) Thiobarbituric acid (TBA) value, petroleum ether-insoluble oxidized fatty acids and insoluble polymer contents oil samples were determined according to the methods of **Sidwell *et al.*, (1954**), and **Wu & Nawar (1986),** respectively. Polar and non-polar components in oil samples were measured by column chromatography according to the method described by **Waltking & Wessels (1981)**. All physical and chemical determinations for non-fried and fried oil samples were carried out three and the results are presented as average values.

The fatty acid methyl ester's by gas liquid chromatography according to [FARAG et al., 1984], unsaponifiable matter composition of the samples was determined by analyzed using gas liquid chromatography according to [MORDERT, 1968] and oxidative stability by Rancimat method at 100°C ± 2°C were determined according to the method of [EVANGELISTI et al., 1997].

- ***Frying process:*** Semal, monsa and cotton seed oils were sued for frying potato chips as follows: A known amount (ca. 2kg) of each system was placed separately in a stainless steel pan fryer (20cm diameter X 25cm height). The aforementioned oils and their mixtures were separately heated at 180°C ± 5°C, then a lot of potato chips (2mm thickness) previously soaked in sodium chloride solution (10 %, w/v) were fried. After frying of potato chips and at end of each day, sample oils were withdrawn and stored in brown bottles at 20°C until analysis.

- ***Statistical analysis:*** Analysis of variance was carried out using stat graphic statistical package (Statistical Graphics Corporation, Version 4, Rackville, USA) including multiple range tests ($P \geq 0.05$) for separation of least square means.

Results and discussion

- ***Chemical composition of the semal and monsa seeds:*** *Table (1)* shows the major chemical composition of semal and monsa seeds. The obtained data indicated the moisture contents of semal and monsa seeds were 8.70 % and 7.75 % respectively. *Bombacaceae* seeds are considered a good source of oil and protein. The highest percent of crude oil (28.50 %) is found in semal seeds, while monsa seeds contained (25.15 %) as crude oil. Theses percentage are high comparable to those of other oil seeds such as cotton seed (20.00 %) [HUI, 2006]**).** The protein content of semal and monsa seeds was found to be the second component in seeds. The percentages were 21.30 % and 23.50 %, respectively. Ash content was found at 5.50 % and 5.00 % for semal and monsa seeds. The results in Table 1 indicated also that carbohydrates content and crude fiber of semal and monsa seeds were higher in semal seeds (16.40 % and 25.50 %), respectively. While monsa seeds (14.65 % and 22.40 %), respectively. On the other hand, these results are in agreement with those reported by **Soliman & Abd-Kadir (2005) & Olaposi; & Adunni (2010).**

Table 1.

Chemical composition (%) of semal and monsa seeds.

Ingredients	Semal seed	Monsa seed
Moisture	8.70±1.30	7.75±1.25
Protein	21.30±2.25	23.50±2.32
Oil	28.50±2.41	25.15±2.43
Fiber	25.50±2.30	22.40±2.29
Ash	5.50±0.85	5.00±0.80
Carbohydrates	16.40±1.93	14.65±1.63

The data are expressed as mean values ± standard error.

- *Physico-chemical properties of semal, monsa and cotton seed oils:* *Table 2* shows the physico-chemical properties of semal, monsa and cotton seed oils. The obtained data indicated that the refractive index of oils were 1.1674, 1.4669 and 1.4680 for semal, monsa and cotton seed oils respectively. The specific gravity of the oils was 0.9180, 0.9178 and 0.9185, respectively. The values were above the recommended codex standard for edible vegetable oils. The color at yellow 35 of semal and monsa seed oils are clear yellow with 1.80 and 1.60 Red Lovibond, while cotton seed oil is dark yellow with 2.20 Red Lovibond. Smoke point of monsa seed oil was lower (225˚C) than those of semal (230˚C) and cotton (233˚C) seed oils. Acid value is the measure of the extent to which the glycosides in oil have been decomposed by lipase [LHEKORONYE & NGODDY, 1985]. Acid value of semal seed oil was higher (0.19 mg KOH/g) than those monsa (0.11 KOH/g) and cotton (0.09 mg KOH/g) seed oils. Peroxide value is an indicator of deterioration of fats [EBUEHI & AVWOBOBE 2006].

Table 2.

Some physical and chemical properties of semal and monsa seeds oil compared with cotton seed oil.

Parameters	Semal seed oil	Monsa seed oil	Cotton seed oil
Specific gravity at 25˚C	0.9180±0.07	0.9178±0.06	0.9185±0.04
Refractive index 25˚C	1.4674±0.09	1.4669±0.09	1.4680±0.09
Viscosity at 17˚C	68.10±5.10	66.70±4.90	71.80±4.93
Colour at yellow 35 Red	1.80±0.10	1.60±0.09	2.20±0.19
Smoke point (˚C)	230.00±10.50	225.00±9.92	233.50±10.65
Acid value (% as oleic acid)	0.19±0.01	0.11±0.003	0.09±0.003
Peroxide value	1.41±0.10	1.35±0.10	1.20±0.01
Thiobarbituric acid (TBA)	0.001±0.00	0.001±0.00	0.010±0.00
Iodine number (Hanus)	98.00±6.0	97.50±6.15	100.50±7.00
Unsaponifiable matter (%)	1.10±.0.10	1.18±0.10	1.23±0.10
Oxidative stability (hr)	14.50±2.00	15.40±.10	14.10±1.98

The data are expressed as mean values ± standard error.

Available on-line at http://dse.usab-tm.ro/en/bjb.html
Banat's Journal of Biotechnology
2011, II(3),

Peroxide of semal seed oil was higher (1.41 meq./ kg) than those of monsa (1.35 meq./kg) and cotton (1.20 meq./kg) seed oils. The iodine value obtained of semal and monsa seed oils were 98.00 and 97.50 Hanus. These values were lower than the value of cotton seed oil (100.50). The lower iodine value signifies low degree of unsaturation and the lesser the liability of the oil to become rancid by oxidation. The unsaponifiable matter (%) of semal seed oil was lower (1.10 %) than those monsa(1.18 %) and cotton (1.23 %) seed oils. Results from Table 2 indicated that the oxidative stability of semal, monsa and cotton seed oils on 100˚C±2˚C using Rancimat method was 14.50, 15.40 and 14.00 hours, respectively.

- *Fatty acids composition:* The fatty acids composition of fresh oils (semal, monsa and cotton) was identified by gas liquids chromatography and the obtained results are tabulated in *Table (3)*. The results showed that semal and monsa seed oil contains linoleic (44.59 % and 43.36 %), palmitic (22.50 % and 23.20 %) and oleic (20.44 % and 19.98 %) acids as major fatty acids. Unsaturated fatty acids such as oleic, linoleic and linolenic acids account for more than 64 % of total fatty acids. This explains oiliness of the oils were stays in a liquid form at room temperature. Saturated fatty acids on the other hand, account for approximately 34 % of total fatty acids. It is also found that the fatty acids compositions of bombax and chorisia seed oil are comparable to cotton seed oil *(Table 3)* especially in the composition of palmitic, oleic and linoleic acids. It is plausible to say that oils (semal and monsa) may be a suitable substitute for cotton seed oil, which has been typically used as salad, frying oil and in the preparation of shortening and margarines [SALMIAH et al., 1996 & HUI, 2006].

Table 3.

Fatty acids composition (%) of semal and monsa seed oil compared with cotton seed oil.

Fatty acids	Semal seed oil	Monsa seed oil	Cotton seed oil
C14:0	0.00±0.00	0.44±0.01	0.00±0.00
C16:0	22.50±2.10	23.20±3.20	23.90±2.20
C16:1	0.28±0.01	0.49±0.01	0.13±0.01
C18:0	9.72±1.00	10.69±0.98	3.50±0.80
C18:1	20.44±2.40	19.98±2.19	19.10±2.22
C18:2	44.59±3.40	43.36±3.00	51.10±3.51
C18:3	0.44±0.10	0.48±0.01	0.62±0.09
C20:0	1.78±0.20	1.06±0.15	0.90±0.15
C20:1	0.25±0.01	0.30±0.01	0.12±0.01
Total saturated	34.00±2.90	35.39±3.00	29.30±2.40
Total unsaturated	66.00±5.20	64.61±5.00	70.70±6.10

The data are expressed as mean values ± standard error.

- Some physical properties of non fried and fried semal, monsa and cotton seed oil:

- *Refractive index:* The data presented in *Figure 1* show that the refractive index increased gradually during frying process in all oils (semal, monsa and cotton seeds). No significant difference (P ≥ 0.05) was found between cotton seed oil and other oils (semal and monsa) during frying period.

- *Color index:* The color of the fried potato chips is one of the most important quality factors of acceptance for fried products. Frying process caused a significant a darkness, which was measured as red slid using the Lovibond Tintometer. The results in *Figure 2* indicated that the using of oils (semal and monsa) caused a significant slight decrease in color values compared with cotton seed oil.

- *Viscosity:* *Figure 3* shows the changes in the viscosity of oil samples under investigation. Generally, viscosity values were increasing gradually during frying period. Using semal and monsa seed oils in frying did not significant differences (P ≥ 0.05) of viscosity values compared to cotton seed oil.

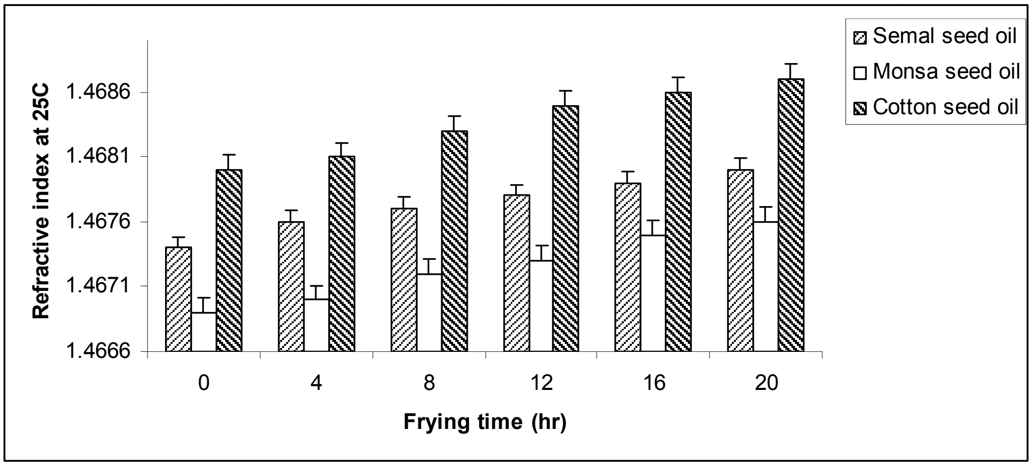

Figure 1. Changes in refractive index of semal, monsa and cotton seed oils during frying process.

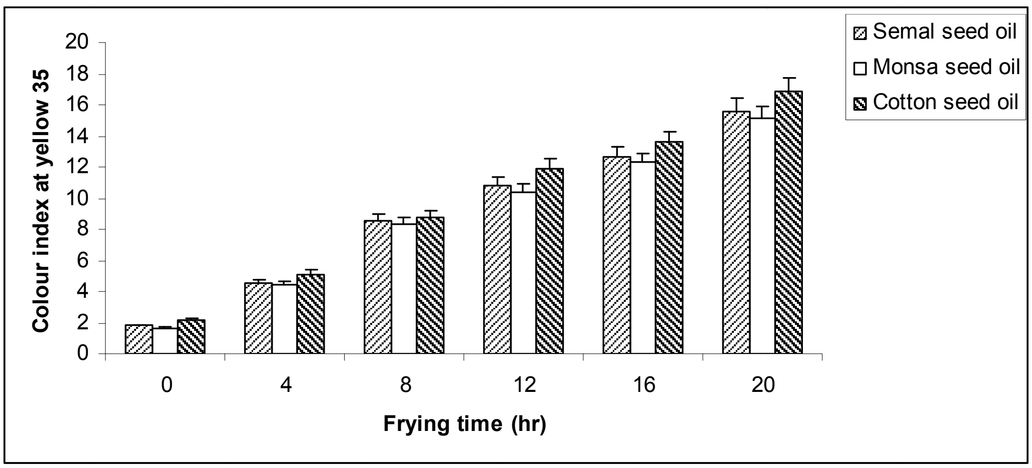

Figure 2. Changes in the colour index of semal, monsa and cotton seed oils during frying process.

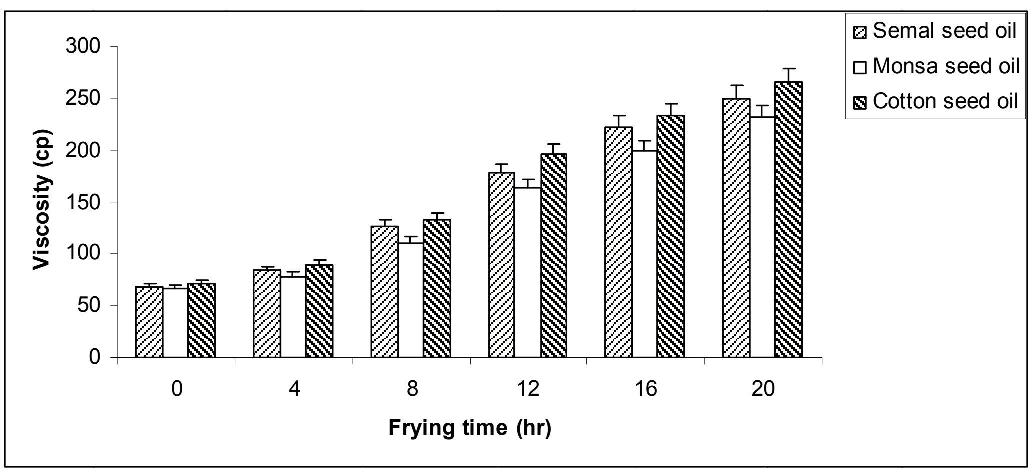

Figure 3. Changes in viscosity of semal, monsa and cotton seed oils during frying process.

- Smoke point: *Figure 4* the changes in smoke point of non fried and fried (semal, monsa and cotton) seed oils. The values of smoke point of fried oils were gradually decreased during frying process. No significant difference (P ≥ 0.05) was found between cotton seed oil and other oil samples (semal and monsa) during frying period.

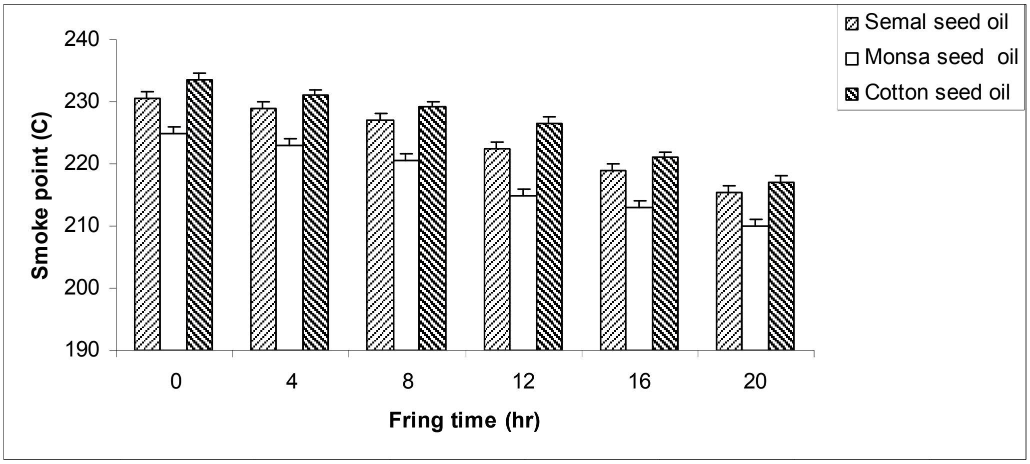

Figure 4. Changes in smoke point of semal, monsa and cotton seed oils during frying process.

- Some chemical properties of non fried and fried semal, monsa and cotton seed oils:

- Acid value: The data illustrated in *Figure 5* indicate that the acid value of samples increased significantly (P ≥ 0.05) during frying and was strongly correlated with prolonging the frying period. Using semal and monsa seed oils in frying process did not differences compared with cotton seed oil.

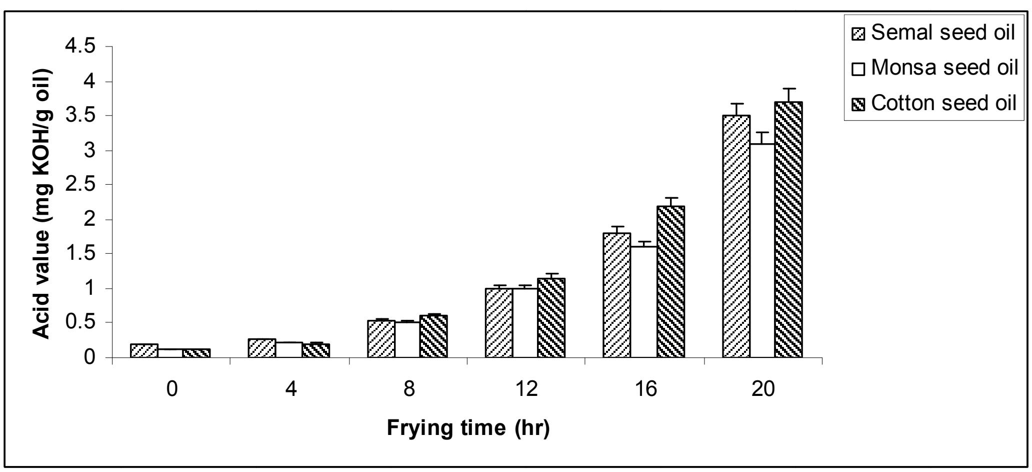

Figure 5. Changes in acid value of semal, monsa and cotton seed oils during frying process.

- Peroxide value: Hydroperoxides are the primary products of lipid oxidation; therefore its determination can be used as oxidation index of the early stages of lipid oxidation [HUI, 2006]. *Figure 6* shows the changes in peroxide values of oil samples under investigation during frying period. The results indicated the using of oils (semal and monsa) not significant differences in hydroperoxides produced during frying process compared with cotton seed oil.

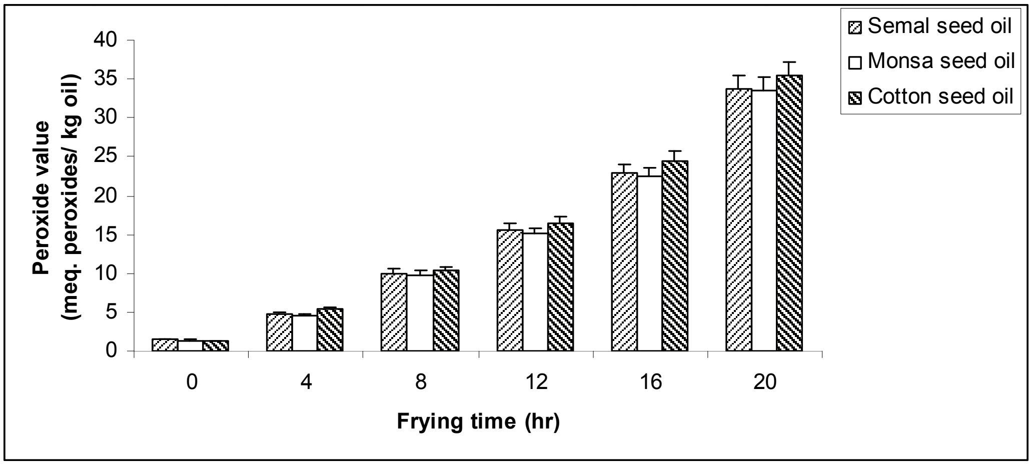

Figure 6. Changes in peroxide value of semal, monsa and cotton seed oils during frying process.

- Thiobarbituric acid value (TBA): There are two stages of oil oxidation, i.e the first stage is the formation of hydroperoxides and the second one is the decomposition of hydroperoxides to produce secondary oxidation products, which could react with TBA reagent to produce colored compounds that absorbs usually at 530 nm [ORTHOEFER & COOPPER, 1996]. Data present in *Figure 7* illustrate the changes in TBA values (secondary oxidation products of oil samples during frying process. Data showed that the TBA values of all oils increased gradually at the frying period. In addition, no significant differences between cotton seed oil with semal and monsa seed oils during frying process.

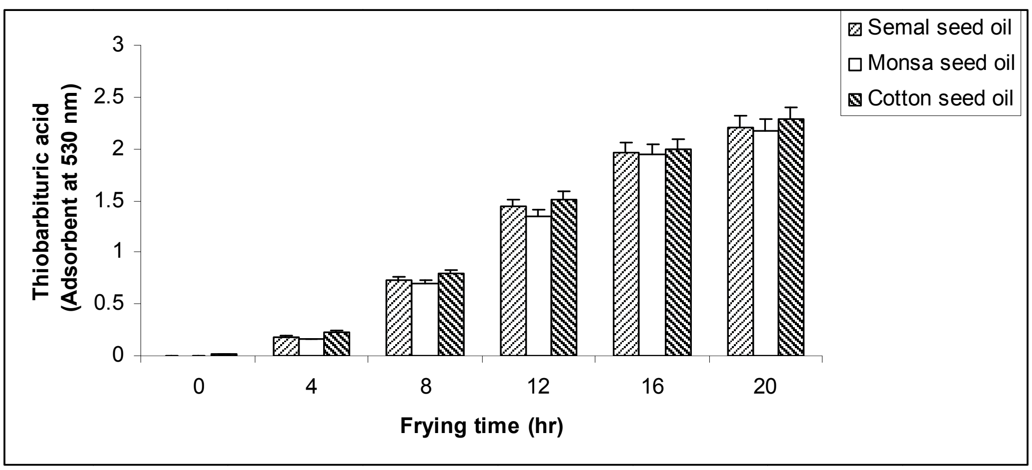

Figure 7. Changes in Thiobarbituric acid (TBA) of semal, monsa and cotton seed oils during frying process.

- Oxidized fatty acids: The initial values of oxidized fatty acids in non-fried oils (semal, monsa and cotton) were 0.00%. On frying oils under the aforementioned conditions, the levels of oxidized fatty acids were gradually and significantly ($P \geq 0.05$) increased throughout the frying process. Using semal and monsa seed oil did not significant differences compared with cotton seed oil. Therefore, one would recommend using these oils in frying process *(Figure 8).*

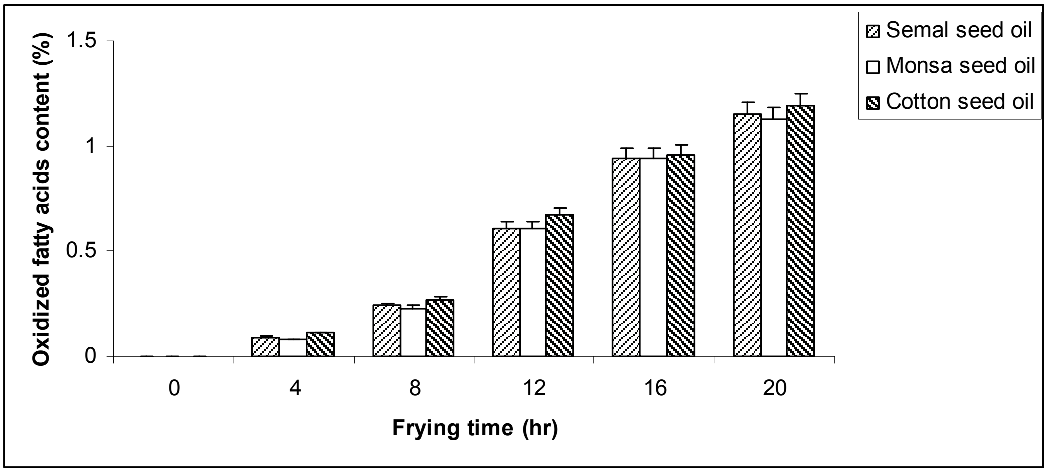

Figure 8. Changes in oxidized fatty acids content of semal, monsa and cotton seed oils during frying process.

- ***Polar content:*** *Figure 9* indicates that the levels of polar compounds of fried oils were gradually and significantly ($P \geq 0.05$) increased towards the end of the frying process. No significant difference ($P \geq 0.05$) was found between cotton seed oil and other oil samples during frying.

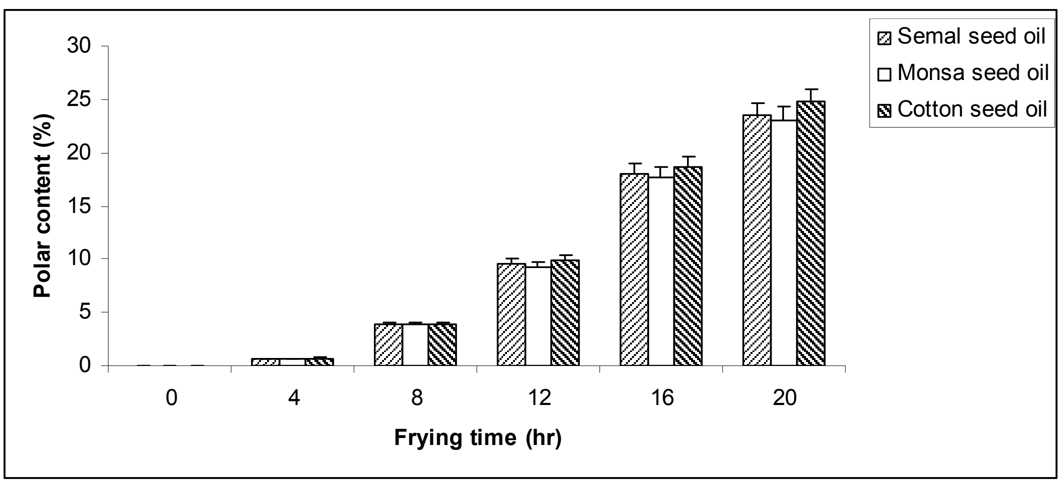

Figure 9. Changes in polar content of semal, monsa and cotton seed oils during frying process.

- ***Polymer content:*** The initial polymer content of non-fried oils was 0.00% and this value was increased progressively with the frying period *(Figure 10).* The results also illustrated that polymer contents of samples (semal and monsa) were almost equal with cotton seed oil.

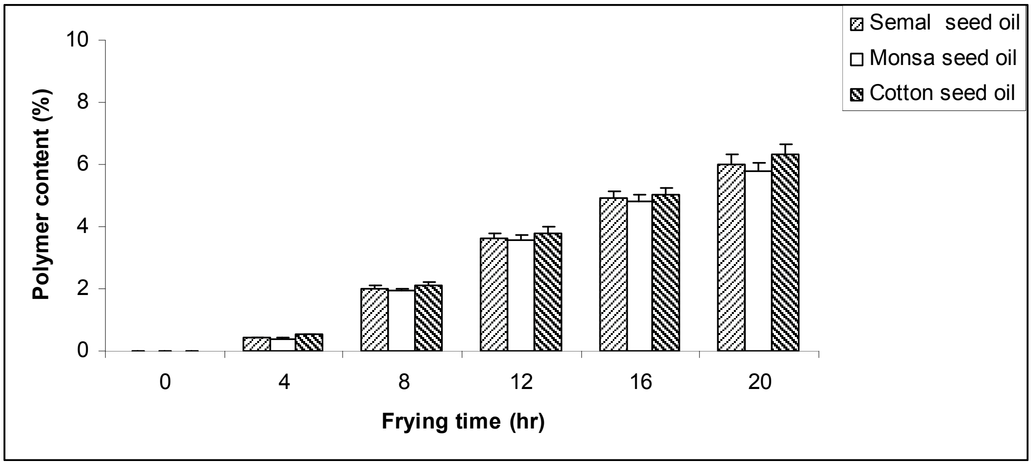

Figure 10. Changes in polymer content of semal, monsa and cotton seed oils during frying process

Conclusion

The outcome of the present study indicated that these properties of semal (*Bombax*) and monsa (*Chorisia*) seed oils and fatty acids composition are similar to the properties of cotton seed oil (The best frying oil) and therefore, these oils can be used in the frying process and other food applications to bridging the part of the gap between production and consumption of edible oils and fats in Egypt.

References

1. AOAC (**2005**). Official Methods of Association of Agriculture Chemists, 18th Edn. Washington, DC: AOAC.
2. Akoh, C. C. (**1988**): Food Lipids: Chemistry, Nutrition and Biotechnology. In Akoh, C.C & Min, D. B. (Ed). Lipid-Based Synthetic fat Substitutes. USA: Marcel Dekker, Inc. pg 559-588.
3. Ebuehi, O. A. & Avwobobe, O. K. (**2006**): Physico-chemical and fatty acids composition of water mellon (*Citrillus lanatus*) and mellon (*Colocynthis citrillus*) seed oils. Nig. Food J., 42: 25-33.
4. Evangelisti, F., Zunin, P., Tisconia, E., Petacchi,R., Drava, G. & Lanteri, S. (**1997**): Stability to oxidation of virgin olive oils as related to olive condition: study of polar compounds by chemometric methods, J. Am. Oil, Chem. Soc. 74 (8): 117.
5. Farag, R. S., Abdel-Rahim, E. A., Elsharabasy, A. M., Hewedy, F.M. & Ragab, A. A (**1984**); Biochemical studies on lipids of hens egg during incubation. Seifen de-fette, Wachse 100:63.
6. Frank, T. O. (**1998**): Vegetable oil. Bailey′s Industrial Oil and Fat Product, 1: 19-44.
7. Hui, Y.A. (**2006**). Bailey's Industrial Oil and Fat Products, 5th edn. New York: Wiley Interscience Publication, John Wiley & Sons.
8. Joslyin, M.A. (**1950**). Methods in Food Analysis. New York: Academic Press, Inc.
9. Kelley, D. S. and Rudolph, I. L. (**2000**): Effect of individual fatty acids of n-6 and n-3 type on human immune status and role of Eicosaniods: short overview. Nutrition 16: 143-145.
10. Hossain, E.; Mandal, S. C. & Gupota, J. K. (**2011**): Photochemical screening and in-vivo antitpyretic activity og the methanol leaf extract of bombax, tropical , Journal of pharmaceutical Research, 10 (1) 55-60.
11. Lhekoronye, A. I. & Ngoddy, P. O. (**1985**): Food lipids. Integrated food science and technology for the tropics. Macmillian Publisher, pp: 58-85.
12. Linnie, T. A.; Stewaed, D. K. (**2001**): Balance between n-6 and n-3 fatty acids and the risk of coronary heart disease. The Editorial Opinions. Nutrition 17 (9): 741-742.
13. Chin, H. F. & Enoch (**1988**): Malaysian trees in colour. Kuala Lumpur. Art Printing Sdn. Bhd.
14. Marzinek, J. & Mourao, K. S. M. (**2003**): Morphology and anatomy of the fruit and seed in development of Chorisia apeciosa A. St.-Hil.-Bombacaceae. Revista Brasil. Bot., V. 26, N 1, P. 23-34.
15. Mordert, F. (**1968**);Comprison and study of methods of obtaining Unsaponifiable matter. J. Crops Grasses, 6: 389-397.
16. Niazi, J.; Gupta, V.; Chakarborty & Kumar, P.

Available on-line at http://dse.usab-tm.ro/en/bjb.html

Banat's Journal of Biotechnology

2011, II(3),

(**2010**): Antiinflammatory and antipyretic activity of leuritis moluccana leaves. Asian J Pharm Chin. Res. 3(1): 35-37.

17. Nielsen, S.S. (**1998**). Food Analysis, 2nd edn. Pp. 222–223. Geithers-burg, MD: Aspen Inc.
18. Odoemeclam, S. A. (**2005**): Proximate composition and selected physicochemical properties of seeds of African oil bean (*Pentaclethra macrophylle*). Pak. J. Nutr. 4: 382-383.
19. Olaposi, A. R.; & Adunni, A. O. (**2010**): Nutritional and physico-chemical properties of *Bombax Glabrum* seeds. Pakistan Journal of Nutrition. 9(9): 856-857.
20. Salimon, J. & Abd Kadir, K. A. (**2005**): Fatty acid composition and physical properties in Kekabu seed oil. Sains Malaysiana, 24 (2): 117-120.
21. Orthoefer, F. T. & Cooper, D. S. (**1996**): Evaluation of used frying oil. In deep-frying chemistry, Nutrition and practical application, Perkins E.G. and Erickson M. D. Eds., AOAC press: Champaign, 1L, USA.
22. Salmiah, A,; Zainab, I.; Rubaah, M. & Rohana, A. (**1996**): Oleochemicals in Malaysia towards value addition. Palm Oil Technical Bulletin, 2 (3): 2-5.
23. Sidwell, G.G., Harold, S., Milado, B. & Mitchell, J.H. (**1954**). The use of thiobarbituric acid as a measure of fat oxidation. Journal of the American Oil Chemical Society, 63, 1363–1367.
24. Troup, R. S. (**1981**): Forest Research Institute and college, Dehradun, India. (1981 reprint) Silviculture of India Trees, Vol. III.
25. Waltking, A.E. & Wessels, H. (**1981**). Chromatographic separation of polar and non-polar components of frying oils. Journal of the Association of Official Analytical Chemistry, 64, 1329–1330.
26. Wu, P. F. & Nawar, W. W. (**1986**): A technology for monitoring the quality of used frying oils. Journal American Oil Chemistry Society, 63: 1363-1367.

Received: April 23, 2011
Accepted: May 23, 2011