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Effect of Vitamins A and E Fortification on the Oxidative Stability of Oils and Their Blends

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ABSTRACT

Egyptian market and nutritional values of oils can be enhanced by adding vitamins A and E. Vitamin A lower the risk of heart disease and vitamin E is an important lipophilic antioxidant that protects cell membranes from oxidation. This study aimed to develop functional oils fortified with vitamins A and E at 0.6% to increase intake of vitamins A and E in order to correct or prevent vitamin A deficiency and to upgrade their nutritional and oxidative stability. Sunflower, Cottonseed and Palm olein oils were fortified with vitamins A and E used to formulate ten oil blends for salad and frying purposes. The effects of fortification and blending different oils on fatty acids profile, identity characteristics and oxidative stability using rancimat method at 110ºc and oxidative stability index (OSI) were evaluated and compared with unfortified oils Palm olein oil is the highest of oleic acid and total saturated fatty acids (46.0%) followed by cottonseed oil (20.06%) and sunflower oil (10.2%). Blend 6F was the highest in palmitic acid, total saturated fatty acids, and the lowest in linoleic acid, total unsaturated fatty acid and medium in oleic acid. Both palm olein and sunflower oils contain the high content of monounsaturated fatty acid (oleic acid). The acid value of oils and their blends ranged between 0.09 to 0.11, whereas the corresponding peroxide value ranged from 0.6 to 1.0 meqo2/kg respectively. Palm olein has a very high OSI value of 21.9 and higher saturated fatty acid of 45.12%, which both cottonseed oil and sunflower oil contain less saturated fatty acid (20.6%, 10.2% respectively) but do not possess as high OSI value (9.9). OSI of oil blends increased as a result of using 5, 10 and 15% palm olein as the induction period (PI) increased from 9.9 hrs. to 11.7 hrs. (blend 3F, 6F). Also, there oil blends had the highest relative stability (R.S.%) The OSI and RS% values of fortified oil and their blends with vitamins A and E were higher compared to corresponding nonfortified ones. The protective effect of vitamin E is highest in sunflower, palm olein blends (1Ff, 2Ff, 3Ff) followed by cottonseed, palm olein- blends (4Ff, 5Ff, 6Ff) and sunflower + cottonseed + palm olein blends (7Ff, 8Ff, 9Ff, 10Ff) respectively. Therefore, edible oils can be improved in their oxidative stability through vitamins A and E fortification.

Key word: Oil fortification and blending, Oxidative stability index, Vitamin A and E, Identity characteristics, Fatty acid profile.

Introduction

Food fortification means adding specific vitamins and minerals, show to be deficient in the diets of the general population or a specific target group of individuals within a country, to the foods most commonly eaten, in order to prevent or address deficiencies. The most obvious way to do this is by incorporating the micronutrients into staple foods such as flour, cooking oil or even condiments. As a result of fortification, population benefits from a diet that contains the missing vitamins and minerals without any effort or need for any form of behavior change (Sight and life, 2012).

The goal of a vitamin A and E fortification is to prevent vitamin A deficiency. Its objectives are to increase vitamin A intake and to improve vitamin A status among population groups whose daily dietary need for vitamin A are not routinely met, (Klemm *et al*., 2010).

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The quality of cooking oil (assessed by peroxide values) period of fortification has been highlighted in (Laillou *et al*., 2013), as a potential barrier to ensuring the stability of retinyl palmitate. The oxidation level greatly interacts with the stability of vitamin A added to the oil.

Sunflower oil (SF) with high levels of poly unsaturated fatty acids (PUFA) is one of the main oils used for cooking and frying. This oils, however, is not quite suitable for frying due to oxidation at elevated temperatures (Anwar *et al*., 2007). Therefore, the use of more stable frying oils of comparatively low price would be desirable. To overcome the problem of poor oxidative stability (OS) of traditional oils, ways of reducing the unstable (PUFA) content and increasing natural antioxidants were sought. One way to improve the (OS) of these oils is by blending with oils of high-oleic acid contents and/or high antioxidant levels (Anwar *et al*., 2007; Ramadan *et al*., 2008 and Aly-aldin 2009). Antioxidants' effectiveness depends on their chemical reactivity (as radical scavengers or metal chelators), interaction with food components, environmental conditions (e.g., pH and concentration) and physical location of the antioxidant in food systems (Lucas *et al*., 2010).

Vegetable oils are suitable vehicles for fortification with the fat-soluble vitamins A, D and E as the production and refining of the oils is a centralized process (Diosay and Venkatesh , 2013). These vitamins from a true solution and are uniformly distributed in oil. The stability of vitamin A is greater in oils than in any other food, and oil facilitates the absorption of vitamin A by the body. Stabilized vitamin forms remain active in the end product, even when used for frying (Diosay and Venkatesh , 2013).

There are two reasons why margarines and oils are ideal food for vitamin A fortification. Not only are the oil-soluble forming of the vitamin the cheapest available, but the oil protects the vitamin A from oxidation during storage and so facilitates absorption of the vitamin (Allen *et al*., 2006).

The stability of vitamin A in previously unopened pails of oil is excellent, although up 30% losses can occur in opened pails after 30 days of storage vitamin A retention in the oil is also good, with only 10% less after 30 minutes of heating (Sustain, 1998).

Egypt as well as many low income countries imports oils and fats through commercial channels. Imported oils are often refined at a limited number of private or government prior to national distribution, making centralized oil fortification feasible (Klemm *et al*., 2010).

Since vitamin A oxidizes as well as fats and oils by free-radical-initiated chain reaction mechanism, vitamin A dissolved in oil will be greatly affected by the availability of free radicals and antioxidants in the system. Peroxide value is a measure of the oxidative stability of oil and is a critical parameter in ensuring stable fortified oil. Vitamin A competes for free radicals with the oil and acts as an antioxidant. According, free-radical scavengers, such as phenolic antioxidants, will protect both the oil and the added vitamin A from oxidative degradation (Diosay and Venkatesh, 2013).

Tocopherol's are good antioxidants for oils and vitamin A. When they supplement the naturally occurring tocopherol in crude vegetable oils or replace them after their reduction during refining, tocopherols are much more expensive than phenolic antioxidants. As the phenolic antioxidants are volatile at high temperature, they are less effective than tocopherols in protecting vitamin A at high frying temperature. (Diosay and Venkatesh, 2013).

One of the priority objectives of the National food and Nutrition policy in Egypt National Nutrition Institute, (2007-2017) is support food fortification activities and programs to eliminate micronutrient deficiency of Iron, vitamin A, iodine, zinc, selenium, calcium, magnesium, vitamin B group, Folic acid etc, (National Nutrition Institute, 2007-2017).

Good frying oil is one which resists both oxidative and hydrolytic rancidity and exhibit good sensory characteristics. Saturated fatty acids are less susceptible to oxidation and longer chain fatty acids are less likely to produce off-flavors and aromas, pleasant mild flavor and has a low melting point to enhance the heating of food fried in them (Smith *et al.,* 1986).

Cottonseed oil has a mild taste and appears generally clear with light golden color. In prepared food, cottonseed oil is a favorite staple for salad oil, mayonnaise, salad dressing and similar products because of its flavor stability.

Palm oil has a balanced fatty acid composition in which the level of saturated fatty acids is almost equal to that of the unsaturated fatty acids. Palmitic acid (44–45%) and oleic acid (39–40%) are the major component acids along with linoleic acid (10–11%) and only a trace amount of linolenic acid. The low level of linoleic acid and virtual absence of linolenic acid make the oil relatively stable to oxidative deterioration (Lin, 2002).

Oils and fats used for commercial frying applications must be stabilized to prevent any changes caused by oxidation, polymerization or hydrolysis during high temperature use. Modifying the fatty acid composition of the oil is the most common method used to stabilize the frying oil. Blending polyunsaturated oil with more saturated or monounsaturated oils is an option to adjust fatty acid levels to optimal levels.

Blend of palm olein with other vegetable oils can be made to improve the oxidative stability (Berger, 1986).

In this study, a new approach was suggested to increase intake of vitamin A. This approach depends on fortifying vegetable oils with vitamins A and E (Natural antioxidant), with health claims in order to correct or prevent vitamin A deficiency. Therefore, some fortified vegetable oils with vitamin A and E were used in this study to formulate oil blends for salad and frying purposes. The fatty acid profiles, identity characteristics and oxidative stability of fortified and unfortified oils were compared and evaluated.

Materials and Methods

Materials:

1. Refined bleached deodorized corn, sunflower, cottonseed and palm olein oils were obtained from Tanta oil and Soap Company, Egypt.
2. Stock solution was prepared by weighing approximately 0.1 g of mixture into 250 ml volume the flask and diluting to volume Dilution of 1: 15, 1:10 and 1: 20 were approved (Allam and Sayed, 2004) . Oil fortification consists of adding appropriate amount (0.6%) of diluted mixture of vitamins A and E to 100 ml Salad oils (corn oil and sunflower oil) and Frying oils (cottonseed oil, sunflower and palm olein and their blends), according the procedure described by Diosary and Venkatesh-Mannar, (2013) agitates in order to ensure an effective homogenization of the blend.

Methods:

1- Oil Fortification:

Oil fortification consists of adding an appropriate amount (0.6%) of mixture of vitamins A and E to 100 ml Salad oils (corn oil and sunflower oil), and Frying oils (cottonseed oil sunflower and palm olein and their blends), according the procedure described by Diosary and Venkatesh, (2013) agitates in order to ensure an effective homogenization of the blend.

2- Preparation of oil blends:

Table 1: Blend oil samples of sunflower, cottonseed and palm olein

Type of oil	Sunflower (%)	Cotton seed (%)	Palm olein (%)
1F	95	-	5
2F	90	-	10
3F	85	-	15
4F	-	95	5
5F	-	90	10
6F	-	85	15
7F	70	25	5
8F	75	20	5
9F	80	15	5
10F	85	10	5

Acid value and Peroxide number were determined according to the method of A.O.A.C. (2003).

3- Analysis of fatty acids:

The fatty acids of the oils were converted into methyl esters using diazomethane and identified by gas liquid chromatography using a Pyeunicam model PV 4550 capillary gas chromatography fitted with flame ionization detector, the column (1.5m X 4 mm) packed with diatomate C (100-120 mesh) and coated with 10 % polyethylene glycol adipate (PEGA). The column temperature was programmed at 8˚C/min from 70˚C to 190˚C then isothermally at this temperature for 20 min and the nitrogen flow rate was 30 ml/min. detector, injection temperatures, hydrogen and air –flow rates and chart speed were 300˚C, 250˚C, 33 ml/min. and 330ml/min., respectively. The presented fatty acids were identified according to internal standards (Farag *et al*., 1985).

4- Oil Stability:

Stability test was carried out using A 679 Rancimat apparatus (Metrohm Herisan, Switzerland). A 5 gm portion of each test sample was loaded into the reaction vessel cylinder. Three different samples and a control sample were conducted in one batch. The air supply was maintained at 20 ml/min and the heating temperature was kept at 110ºC throughout the experiment as described by (Laubli and Bruttel, 1986).

The oil stability is expressed as the induction time (hr) of hydroperoxide decomposition.

Results and Discussion

1- Fatty acid composition:

Results of fatty acid composition in investigated oils and their blends are given in Table (2). These results indicate that there is a marked difference in fatty acid composition between the three oils used for preparing the ten oil blends. Palm olein is the highest source of oleic acid (n – 9 FA), while sunflower oil is the richest in Linoleic acid (n – 6 FA) followed by cottonseed oil and palm olein. Palmitic acid was found in the highest value in palm olein (40.85%) followed by cottonseed oil (15.21%) and sunflower oil (6.76%) respectively.

The unsaturated fatty acids represented 89.76, 80.00 and 53.82 % of the total fatty acid of sunflower, cottonseed and Palm olein oils respectively. However, palm olein oil was the highest source of total saturated fatty acid (46.12%) followed by cottonseed oil (20.06%) and sunflower oil (10.20%).

Table 2: Relative percentage fatty acid composition (%) of pam olein, cottonseed and sunflower oils and their blend:

Type of oil	Relative percentage								TUS	*Total TS: TUs
	Saturated				TS	Unsaturated				
	C12: 0	C14 : 0	C16 : 0	C18:0		C18 : 1	C18 : 2	C18 : 3		
Palm olein	0.17	0.01	40.85	4.09	45.12	43.10	10.72	0.00	53.82	1: 2.0
Cotton seed oil	0.00	0.36	15.21	4.50	20.06	24.00	55.70	0.30	80.00	1: 4.0
sunflower oil	0.00	0.07	6.76	3.37	10.20	30.09	59.40	0.27	89.76	1: 8.8
1F	0.00	0.20	8.60	3.20	12.00	30.60	57.20	0.20	88.00	1: 7.4
2F	0.00	0.20	10.20	3.40	13.80	31.50	54.50	0.20	84.20	1: 6.2
3F	0.00	0.30	11.90	3.50	15.70	32.00	52.00	0.30	84.30	1: 5.4
4F	0.00	0.40	16.40	4.50	21.30	25.00	53.40	0.30	78.70	1: 3.7
5F	0.00	0.50	17.50	4.50	22.50	26.00	51.20	0.30	77.80	1: 3.5
6F	0.00	0.50	19.00	4.60	24.10	26.60	49.00	0.30	75.90	1: 3.2
7F	0.00	0.30	10.50	3.60	14.40	29.20	56.10	0.30	85.60	1: 6.0
8F	0.00	0.30	10.20	3.50	14.00	29.50	56.20	0.30	86.30	1: 6.2
9F	0.00	0.30	9.70	3.50	13.50	30.10	56.50	0.40	81.00	1: 6.4
10F	0.00	0.30	9.75	3.50	13.55	30.10	56.60	0.40	86.10	1: 6.8

**Total saturated : total unsaturated = TS : TUS*

The ratio between saturated to unsaturated fatty acid was highest in Sunflower oil (1: 08.8) table (2), followed by cottonseed oil and lower in palm olein oil, in spite of the clear variation in their fatty acid composition.

Oil such as Palm olein rich in saturated fatty acid are more stable to oxidative and hydrolytic breakdown and the less to polymerize during heating, however, oils rich in Linolenic acid are particularly susceptible to these undesirable changes upon using in frying process (FAO, 2010).

Among the prepared ten oil blends, blend 6F was the highest in Palmitic acid, total saturated fatty acids, and the lowest in Linoleic acid, total unsaturated fatty acids and medium in oleic acid. The ratio of saturated to unsaturated fatty acids of the blend 4F was similar (1: 3.7) with those of cottonseed oil. In addition to both blends 2F and blend 8F in spite of the obvious variation in their fatty acid composition. The ratio of their saturated to unsaturated fatty acids almost very close (1:6.3 and 1:6.2) respectively.

However, (Abdel- Rahman, 1994) found that blending sunflower oil with palm olein at percentage ranged from 30 to 40% palm olein improve the frying stability. Also, Mostafa *et al*., (1994) found that blended Palm olein with cottonseed oil proved to be useful from both technical and nutrition point of view. These findings coincide with indicate that blends 6F and 5F oils could be used as frying oils, whereas the other oils could be used as cooking and salad oils .

2- Some Identity characteristics of oils stability and their blends:

Some chemical properties of palm olein, cottonseed, sunflower and their blends including acid number and peroxide value as an indication of oil stability are presented in Table (3) indicate the high quality of investigated oils and their blends since both acid value and peroxide value were low in all blended oils. Blending cottonseed and sunflower oils with palm olein improved its quality against hydrolysis and oxidative processes, since the value ranged between 0.09 to 0.11 in cottonseed oil, which was content the lowest acid number followed by palm olein 0.1% and sunflower oil was the highest acid number 0.11% compared with other fresh frying oils. Blend (4F), 0.091 and (5F), 0.091 and blend (6F), 0.092 of frying oil had the lowest acid number compared to the corresponding values of other oil blends. Whereas, the oil blend composed of 95% sunflower and 5% palm olein has the highest acid number being 0.11%.

The peroxide value is the test measures total hydroperoxides formed as the primary oxidation products. The peroxide value ranged between 0.60 to 1.0 meqo_2/kg of fresh frying oils, it could be noticed that results in Table (3) a high quality of cottonseed oil had lowest peroxide number 0.6 meqo_2/kg followed by palm olein 0.7 meqo_2/kg and sunflower oil 1.0 meqo^2/kg.

Table 3: some oxidative characteristics of palm olein, cottonseed and sunflower oils and their blends

Type of oil	Acid value (mg/g)	peroxide value meqo_2/kg oil
palm olein	0.100	0.700
cottonseed oil	0.090	0.600
sunflower oil	0.110	1.000
1F	0.110	0.985
2F	0.109	0.970
3F	0.109	0.955
4F	0.091	0.605
5F	0.091	0.610
6F	0.092	0.615
7F	0.105	0.885
8F	0.106	0.905
9F	0.107	0.925
10F	0.108	0.945

Peroxide value ranged between 0.61 meqo_2/kg to 0.98 meqo_2/kg of oil blends. These results are consistent with research conducted by Laillou *et al*., (2013), who found that vitamin A lossless started when peroxide value reached a level of approximately 2meqo_2/kg and were closely associated with the increase of peroxide (Laillou etal., 2013 and Andarwulan *et al*., 2014).

It could be concluded that, the analysis of oxidative characteristics (PV and AV) of salad and cooking oils should take into consideration before been fortified with vitamin A.

3. **Identity characteristics:**

Our results in Table (4) show some identity characteristics of palm olein, sunflower and cottonseed oils in addition to their oil blends.

Generally, no a significant difference in refractive indexes were observed between palm olein, cottonseed and sunflower oils and their blends, Refractive index ranged from 1.4634-1.4705 among the three oils and their blends respectively. Meanwhile, marked variations were noticed in iodine value and saponification value between the three oils and their oil blends. Iodine value increased with the increase of unsaturation degree or the numbers of double blends in oils and fats. Therefore, the highest value of iodine value was in sunflower oil rich in linoleic acid and the lowest one was in palm olein rich in oleic acid. The other oils can be arranged into three classes according to their content of iodine value.

Table 4: some identity characteristics of palm olein, cottonseed and sunflower oils and their blends

Type of oil	Refractive index at 25°c	Iodine value (Wijs method)	saponification value (mg KOH/g oil)
Palm olein	1.4634	56.920	195.90
cottonseed oil	1.4705	110.000	188.00
sunflower oil	1.4676	132.000	186.02
1F	1.4674	128.246	186.60
2F	1.4671	124.492	177.30
3F	1.4567	120.738	168.00
4F	1.4701	107.346	188.40
5F	1.4698	104.692	188.80
6F	1.4694	102.038	189.20
7F	1.4681	122.746	187.40
8F	1.468	123.846	187.00
9F	1.4678	124.946	186.90
10F	1.4677	126.046	186.80

The class one includes 1F blend with 128.246 iodine value and 1: 7.40 saturated to unsaturated fatty acid ratio. The second class contains cottonseed oil, 9F and 4F oil blends with 124.946 to 107.346 iodine value and 1: 6.4 to 1: 3.70 saturated to unsaturated fatty acid ratio. The third class includes the other vegetable oil blends, palm olein, 3F with 56.920 to 120.738 iodine value and 1: 2.00 to 1: 5.4 saturated to unsaturated fatty acids ratio. The variations in iodine value among there oil sources may be affected their peroxidation stability.

The highest value of saponification number was in palm olein 195.9 followed by cotton seed and sunflower oils 188 and 186.02 respectively

Meanwhile, no a significant difference in saponification value were observed between oil blends and their saponification value ranged from 168.0 to 189.20 among the ten oil blends respectively.

The data in literatures showed that palm olein had 1.4589-1.4592 refractive index at 40ºC (Aly-aldin, 2009) and 55.6 – 61.9 iodine value (Tang *et al*., 1995). Whereas , the typical refined cottonseed oil had 1.4680 – 1.4720 refractive index at 25 ºC , 110.7 Iodine number and 189 – 198 saponification value respectively (Aly-aldin, 2009) sunflower oil had 1.4676 refractive index , 129.4 iodine number and 187.66 saponification value respectively.

On the other hand, result in Table (4) shows some identity characteristics of fortified three oils and their blends. With vitamin A and E, No obvious differences could be observed due to fortification process. The results reveal that, the addition of vitamins A and E had no change in refractive index, iodine number and saponification value of palm olein, sunflower oil and cottonseed oils and their blends. These results are in agreement with those obtained by (Mostafa *et al*., 1994).

According to obtained results, it can be concluded the following:

1. Identity characteristics and composition of oil blends were based on their raw materials.

2. Increasing the proportion of palm olein in the oil blends was associated with a decrease in a iodine value and a saturated to unsaturated fatty acid ratio. The opposite trend was noticed with increasing sunflower oil in such blend.

4. **Oxidative Stability (OSI) of vegetable oils and their blends:**

Table (5) should that The induction period using the Rancimat method of palm olein at 110ºC was much higher than that of both cottonseed and sunflower oils as the induction period at 110 ^{O}C were 21.9 and 9.9 hrs for palm olein and both cottonseed sunflower oils respectively. These findings coincide with that found by Mostafa *et al*. (1996).

However, induction period of Palm olein was found to be the highest one among tested oils such as cottonseed and sunflower oil (9.9 hrs). This means that the stability of investigated palm olein is about more than twice the stability of other oils. Palm olein has a very high OSI value of 21.9 and higher saturated fatty acid of 45.12%, while both cottonseed oil and sunflower oil contain less saturated fatty acid (20.06%,10.2%, respectively) but do not possess as high OSI value (9.9).

It has been found that palm olein oil has the highest OSI value of observed 21.9 hours. Among the test oils, it is found that their observed OSI values conformed to the basic the principle that of saturated oil can with stand oxidation reaction better than mono unsaturated and polyunsaturated oil. Palm olein oil was found to contain the highest amount of saturated fatty acid (45.12 %). As such incorporating palm olein oil has the highest OSI value among other oils. The same results reveal also that the oxidative stability index of the oil blends showed a remarkable increase as a result of using 5, 10 and 15% palm olein as the induction period at 110°c increased from 9.9 hrs in cottonseed oil and sunflower oil to 11.7 hrs (blend 3F, 6F), and from 9.9 hrs to 11.1 hrs (blends 2F and 5F). Therefore, blending cottonseed oil and sunflower oil with palm olein improved the oxidative stability of investigating oils and their blends. These results are in good agreement with those obtained by Mostafa *et al*. (1994).

The relative stability (R.S.%) of vegetable oils and their blends was calculated and also presented in Table (5). Blends (3F) and (6F) had the highest relative stability among the other investigated oils and blends (2F,5F) followed by blends (1F,4F,8F,9F,10F) and both cottonseed oil and sunflower oil.

Table 5: Oxidative stability of some vegetable oils and their blends

Type of oil	Saturated fatty acid (SFA)%	Mono un saturated fatty acid (MUFA)%	Poly un saturated fatty acid (PUFA)%	OSI at 110°c (hours)	Relative stability %
Palm olein	45.12	43.1	10.72	21.90	100
Cotton seed oil	20.06	24.0	56	9.9	45.2
Sunflower oil	10.20	30.09	59.67	9.9	45.2
1F	12.00	27.0	60.6	10.5	48.0
2F	13.80	27.72	57.3	11.1	50.7
3F	15.70	28.8	55.0	11.7	53.5
4F	21.30	24.4	54.34	10.5	48.0
5F	22.50	25.6	52.4	11.1	50.7
6F	24.10	27.0	50.53	11.7	53.5
7F	14.40	26.5	58.03	10.5	48.0
8F	14.00	26.54	59.08	10.5	48.0
9F	13.50	26.7	59.38	10.5	48.0
10F	13.55	26.8	59.11	10.65	48.0

5. **Oxidative stability of fortified vegetable oils and their blends:**

The oxidative stability values of the fortified and unfortified vegetable oils and their blends were determined using the Rancimat method. The Rancimat was set to condition at temperature of 110^{O}C. The OSI values were observed and results are shown in Table (6, 7).

Generally, it could be noticed that the OSI and RS% value of fortified oil and their blends with vitamin A and E were higher compared to the corresponding nonfortified. Therefore, the impact of added vitamin E for stabilization of oil blends and vitamin A indicate a protective effect and caused a significant retardation of oil out- oxidation. Consequently, vitamin E could be playing a protective role in vitamin A in vitamin A-fortified oils. The obtained results coincide with those mentioned by Allam and El-sayed (2004) and Dolde (2009), who indicated that potato chips fortified with vitamin A by frying in oil containing vitamin E had better storage ability at 63°c, beside enhanced their nutritional value. In addition, it could be concluded that vitamin E (tocopherol) as natural antioxidant when added to the fortified oils with vitamin A lead to reduce the rate of oxidative rancidity of both oils and vitamin A. In this respect, tocopherols (vitamin E) are more effective than phenolic antioxidants in protecting vitamin A (Diosay and Venkatesh , 2013).

Table 6: Effect of vitamin A and E fortification on OSI of sunflower oil and palm olein and their blends

Blend number		OSI (hours)		Relative stability (RS)		Blend number		*OSI (hours)		Relative stability (RS)	
		Before	After	Before	After			Before	After	Before	After
Ratio of sunflower oil : Palm olein						Ratio of cottonseed oil : Palm olein					
Sun flower	100 : 0	9.9	13.0	45.2	51.6	Cotton seed oil	100 : 0	9.9	12.6	45.2	50
1Ff	95 : 5	10.5	13.61	42.0	54.0	4Ff	95 : 5	10.5	13.23	48.0	52.5
2Ff	90 : 10	11.1	14.22	50.7	56.4	5Ff	90 : 10	11.1	13.86	51.2	55
3Ff	85 : 15	11.7	14.83	53.5	58.8	6Ff	85 : 15	11.7	14.49	53.5	57.5
Palm olein	0 : 100	21.9	25.2	100	100	Palm olein	0 : 100	21.9	25.2	100	100

Table 7: Effect of fortification sunflower and cottonseed oils with A and E

Blend number	Ratio of sunflower oil: cotton seed oil : Palm olein	*OSI (hours)		Relative stability %	
		Before	After	Before	After
Sunflower oil	100 : 0 :0	9.9	13.0	45.2	51.6
Cottonseed oil	100 : 0 : 0	9.9	12.6	45.2	50
7Ff	25 : 70 : 5	10.5	13.51	48.0	53.6
8Ff	20 : 75 : 5	10.5	13.53	48.0	53.7
9Ff	80 : 15 : 5	10.5	13.55	48.0	53.8
10Ff	85 : 15 : 5	10.5	13.57	48.0	53.9
Palm olein	0 : 0 : 100	21.9	25.5	100	100

RS= induction period of sample / induction period of control
**OSI= oxidative stability index (induction time) after = fortified   Before= unfortified*

On the other hand, the protective effect of vitamin E is highest in sunflower, palm olein blends (1Ff,2Ff,3Ff) followed by cottonseed, palm olein-blends (4Ff,5Ff,6Ff) and sunflower + cottonseed + palm olein blends (7Ff,8Ff,9Ff,10Ff) respectively. Table (6, 7), Also, the same trend was observed with their corresponding values of % Relative stability. It could be concluded that the vitamin E, had better oxidative when added to sunflower oil with highest unsaturated and lowest saturated fatty acids compared to other investigated oils palm olein and cottonseed oils, However, the results obtained show that the fortification process of oil blends with vitamin A and E had better oxidative stability and nutritional value compared to non- fortified oil blends.

These results are in agreement with the results of (Andino, 2011) who mentioned that vitamin E is an important natural antioxidant which inhibits lipid peroxidation (Andino, 2011).

Conclusion

It could be recommended to use studied vitamins to improve stability of sunflower, cottonseed and palm olein oils. Governments in African Counters where vitamin A deficiency persists as a public health problem should consider the option of fortifying edible oils with vitamins A and E. to upgrade both nutritional and antioxidant potentialities.

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