

Safety and nutritional quality of commonly consumed commercial edible oils in Addis Ababa

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Abstract

Background: Keeping food safety and quality are the major components of food security and protecting human health. Directly or indirectly, edible oils are involved in every day dish; and due to this, long time preference on the type of edible oil should pay off to the health and development of individuals.

Objective: To analyze physicochemical quality and safety of commonly consumed commercially available oils in Addis Ababa.

Methods: Sixteen different types of solid and liquid edible oils were collected from main shops and supermarkets in Addis Ababa from October to December, 2015. Following the sample collection, physicochemical properties were analyzed using standard methods.

Results: The solid oils have significantly higher iodine value, saturated, monounsaturated, Poly unsaturated fatty acids, Cis, Trans, Omega-6 fats ($p < 0.05$) as compared with the liquid. Palm oils have significantly higher ($p < 0.05$) trans, saturated, monounsaturated and lower omega-6 and cis fats.

Conclusion: Imported palm oils contain surplus amount of saturated fatty acid; and according to the consumption, it is usually surpass the WHO daily recommendation amount. Consequently, to avoid the long term health effect, substituting liquid oils in place of solid is recommended for their many health benefits. Locally produced edible oils contain good Poly unsaturated fatty acids, omega fats, vitamin A and vitamin E; however they need to pass through all the necessary refinery processes such as degumming, , deacidification, bleaching, filtration and deodorization steps.

Key words: Fatty acids, cardiovascular disease, and physicochemical properties.

Introduction

Oil and fat are important constituents of our diet and contribute significantly for the development and regulation of different functions of our body (Tahir et al. 2012). Vegetable oils have been recognized as sources of essential fatty acids, carrier of fat soluble vitamins and enhance palatability of the foods we eat by providing texture, mouth feel, impartation of flavors and contribution to the feeling of satiety after eating (Otinola et al. 2009). However, some vegetable oils are not up to standards to meet the quality, safety, consumer satisfaction in terms of their physicochemical properties, texture and stability of the food products (Position of the American Dietetic Association and Dietitians, 2007).

Industrial processing, especially catalytic hydrogenation of vegetable oils, affects their fatty acid composition. Higher hydrogenation of oil is directly proportional to higher saturation, solidification and presence of trans fatty acid. Highly saturated fatty acid diets have been found to increase the level of cholesterol (Fattore et al. 2014). Several studies have shown that palm oil has a hypercholesterolemic effect because of its high saturation to 50% palmitic acid (C16:0). This high source of saturated fats in the human diet thought to have detrimental effect on human health, particularly

when compared with polyunsaturated fatty acids (PUFAs) (Bautista et al. 2001).

According to the WHO report, there is convincing evidence that palmitic oil consumption contributes to an increased risk of developing cardiovascular diseases (CVDs). These evidences show that dietary saturated fatty acids (SFAs) increase blood total cholesterol (TC) and low density lipoprotein (LDL) cholesterol, which are known to be risk factors for coronary heart disease (CHD) and cardiovascular disease (CVD) (Ness 2004). WHO recommended that; to improve the diet in both populations and individuals level; one of the strategy focused is diet and physical activity (DPAS); limiting energy intake gain from total fats and shift fat consumption from saturated to unsaturated fats and toward the elimination of TFA (Nishida and Uauy 2009).

The liquid Vegetable oils produced in Ethiopia have higher acidity than the country codex Standard (Atnafu and Bedemo 2011). According to data from food, beverage and pharmaceutical industry development institute in April, 2017: In Ethiopia imported and locally processed edible oils are used widely; however the locally processed edible oil production is very low, contributing (1.57%) of the country's supply; for this reason currently the imported palm oils sharing the biggest contribution (96.73%) of the supply in the country (unpublished

data). The objective of this research is to analyze the quality, safety and nutritional content of edible oils which are commonly sold in Addis Ababa.

Materials and methods

Physicochemical analysis of oils: The study was conducted in two phases. The first phase was assessing the physicochemical and fatty acid profile of the oils. And this study serves us a base line for continuing animal trial, which is not included in this paper. A cross sectional study of 16 different edible oils were selected and collected which were found in main shops and supermarkets of Addis Ababa from October to December, 2015. Most of edible oil brands of solid and liquid oils which were stored under room temperature in the market were included. Following sample collection, physicochemical properties of the oils were analyzed.

Physical properties of the edible oils includes: color, odor, whether refined, labeling of the expiry date, present with settle able solids, limpidity of the oil and fortified or not. Chemical properties of edible oils includes: Total fat, peroxide, iodine, acid value, refractive index and specific gravity of the oils were determined using AOAC standard method, (Firestone and Yarawecz, 2016); fatty acid profiles were analyzed using Christopherson and Glass (1969); and sterol was analyzed using dole extraction technique as described by Smuts et al. (1992). Vitamin A (Thomas *et al.* 2011) and Vitamin E (Manz and

Philipp 1981) levels were also determined by using high performance liquid chromatography.

Statistical analysis: Data of the physical properties and nutrient contents of the oils were analysed using SPSS statistical software version 20. Descriptive statistics was used to summarize the findings, and Student t-test and ANOVA were respectively used to test any significant difference between solid and liquid oils, and among locally produced and imported edible oils.

Results and discussion

Physical characteristics of the oils: Among the total of 16 analyzed oil brands, seven were produced in Ethiopia. They haven't fulfilled the necessary food labeling requirements such as nutrition facts, fortification information, expiry date, cholesterol level and refinery information. Five of the locally produced oils were not refined, due to this they colored deep yellow or yellow brown and three of them were found with foreign residual matter. The rest nine brands were imported oils from different countries and five of them were fulfilled necessary oil product labeling requirements however the other four still need improvement in their labeling. All the solid oils included in this study were imported oils, in fact no solid form oil produced in Ethiopia so far (Table1).

Table 1: Physical properties of commercially available edible oils in Addis Ababa

Code	Color	Refining process	Labeling quality	Local/Imported	Expiry date	Existed State	Foreign residue	Fortified
Hamar	Light-yellow	Not refined	Poor	local	Have not	liquid	Have not	No
OO-loret	Greenish-yellow	Not refined	Poor	Imported	Have	liquid	Have not	No
SBO-V	Light-yellow	Refined	Met	Imported	Have	liquid	Have not	No
SBO-GS	Light-yellow	Not refined	Poor	Imported	Have	liquid	Have not	No
CO-Ver	Orange-Yellow	Refined	Met	Imported	Have	liquid	Have not	No
SFO-Hat	Light-yellow	Refined	Met	Imported	Have	liquid	Have not	No
SFO-Moj	Light-yellow	Refined	Poor	local	Have not	liquid	Have not	No
Ni-T&M	Deep-yellow	Not refined	Poor	local	Have	liquid	Have	No
Ni-Dan	Deep-yellow	Not refined	Poor	local	Have	liquid	Have not	No
Ni-NL	Greenish-yellow	Not refined	Poor	local	Have not	liquid	Have	No
CSO-Moj	Yellow- brown	Not refined	Poor	local	Have not	liquid	Have	Yes
SSO-NL	Deep yellow	Not refined	Poor	local	Have not	Liquid	Have	No
Pal-A	light yellow	Refined	Met	Imported	Have	solid	Have not	No
Pal-O	light yellow	Have not	Poor	Imported	Have	solid	Have not	Yes
Pal-V	light yellow	Refined	Met	Imported	Have	solid	Have not	No
SL-Yem	light yellow	Refined	Poor	Imported	Have not	solid	Have not	Yes

Note: Oil brands were presented as codes so as to adhere with trade practice and consumers' protection rights.

Chemical analysis of the oils: Of the 16 analyzed oil samples, acid value of the six locally produced and one imported was out of the country edible oil standard (>0.6 mgKOH/g) (Table 2). Being hydrogenated or solid was significantly associated with high Trans(Craig-Schmidt 2006), saturated and

MUFA but with low Cis, PUFA, omega-3, and omega-6 fatty acids, sterol level, peroxide and iodine value (Table 3). Locally produced oils had higher acid value (1.78 mg KOH/g) and peroxide value (4.42 meq O₂/kg) than the imported (0.52 mgKOH/g and 3.59 meqO₂/kg respectively), which attributed to

incomplete refinery process, presence of moisture which results hydrolysis and elevated temperature

(Vidrih et al. 2010).

Table 2. Chemical compositions of edible oils in Addis Ababa

Code	Peroxide value (meq O ₂ /kg)	Acid value (mgKOH/g)	Iodine value (gI ₂ /100g)	Ref. index at 40 °C	Sp. gravity at 20 °C
Liquid oils					
Hamar	2.07	1.01	133.72	1.477	0.921
OO-loret	6.0	0.60	70.00	1.47	0.915
SBO-V	3.02	0.60	128.85	1.476	0.920
SBO-GS	1.3	0.40	132.44	1.476	0.920
CO-Ver	3.25	0.60	119.60	1.475	0.920
SFO-Hat	4.39	0.40	126.56	1.475	0.920
SFO-Moj	8.81	0.71	120.00	1.475	0.921
Ni-T & M	5.14	1.11	122.76	1.476	0.921
Ni-Dan	5.88	1.86	124.77	1.476	0.921
Ni-NL	3.32	4.13	116.15	1.476	0.890
CSO-Moj	3.9	0.40	105.96	1.474	0.925
FSO-NL	1.82	3.22	145.94	1.478	0.923
Mean	4.08 ± 2.13	1.25 ± 1.22	120.56 ± 18.77	1.475 ± 0.0	0.92 ± 0.0
Median	3.61	0.66	123.77	1.476	0.920
Solid oils					
Pal-A	1.23	0.50	57.52	1.467	0.908
Pal-O	1.34	0.40	62.33	1.467	0.910
Pal-V	4.0	0.40	55.30	1.467	0.910
SL-Yem	0.95	0.80	49.23	1.468	0.910
Mean	1.88 ± 1.42	0.53 ± 0.19	56.10 ± 5.44	1.467 ± 0.0	0.910 ± 0.0
Median	1.29	0.45	56.41	1.467	0.910

Note: The normal ranges for acid value in refined edible oils by codex in 1993 is 0.6 mg KOH/g of oil; accordingly six of the seven locally produced edible oils were unfit to the standard.

The high acidity result in the local unrefined edible oils was agree with the study done by Rajko et al. (2010), which the result shows that unrefined edible oils have high acidity than refined oils. And also refinery process increase the shelf life by removing moisture, acylglycerols, phospholipids, free fatty acids, metal ions and metal complexes which act as a pro-oxidant increasing the oxidation of acylglycerols (Vaisali, et al. 2015). Because of higher degree of unsaturation, liquid oils had higher mean iodine value

(120.6±18.8g/100g) than solid oils (56.1±5.4g/100g); nearly 47g per 100g of the solid palm oils were containing saturated fatty acids. Unsaturation feature of liquid oils which make them susceptible to continuous lipid oxidation in air, sunlight or limited moisture also favors to have higher peroxide value (4.08±2.13) than solid oils (1.88 ±1.42). Locally produced liquid oils had slightly higher peroxide value (4.42 meq O₂/kg) than imported oils (3.59meq O₂/kg) attributed to the presence of impurities.

Table 3: Chemical profile of edible oils used in Addis Ababa

Type of oil	Stero l	Fat	Vit. A	Vit E	SFA	MUF A	PUF A	TFA	CFA	ω ₃ F A	ω ₆ FA	ω ₉ FA	ω ₆ /ω ₃	EPA	DHA
Hamar	199	99.57	0.06	0	17.31	5.91	76.36	0.20	80.51	1.38	75	7.9	54.3	1.10	0
OO-loret	103	99.69	0.04	2.7	17.2	76.2	6.3	0.01	80.15	0.8	5.5	74.8	6.9	0	0
SBO-vik	112	99.54	0.03	2.25	16.7	21.5	61.3	0.05	74	8	53.3	21.2	6.7	0	0
BO-GS	121	99.66	0.03	9.71	16.1	20.5	63	0.05	73.9	8.2	54.8	20.2	6.7	0.02	0
CO-Vera	319	99.63	0.03	2.32	14.3	30.2	55.1	0.03	83.8	0.82	54.3	29.7	66.2	0	0
SFO-Hatun	155	99.6	0.04	0.05	11.8	27.4	60.4	0.02	86.93	0.32	60.1	27.09	187.8	0.01	0
SFO-Mojo	168	99.41	0.06	0.66	12.95	34.6	51.8	0.05	76.76	2.12	49.4	32.91	23.3	0	0
Ni T & M	162	99.77	0.09	29.49	24.5	41.75	22.4	11.08	40.85	11.42	11	51.97	1.0	1.20	0
Ni-Dana	194	99.78	0.05	0	15.8	23.1	60.9	0.03	78.34	5.16	55.69	22.76	10.8	0.48	0.02
Ni-un	202	99.62	0.05	0	16.8	31.1	51.75	0.01	78.56	3.55	48.2	30.44	13.6	0	0
CSO-Mojo	231	99.88	0.04	0.58	27.36	18.16	54.32	0.05	70.63	0.84	53.52	17.42	63.7	0.42	0.02
FSO-un	136	99.37	0.06	3.2	16.69	21.9	60.72	0.06	51.18	30.66	30.06	21.56	1.0	0.10	0.02
Mean	175	99.63	0.05	4.25	17.29	29.36	52.03	1.04	72.98	6.10	45.90	29.64	7.5	0.28	0.00
liquid oils															
Sd	60	0.15	0.02	8.40	4.43	17.30	19.08	3.33	13.51	8.54	20.28	17.97	2.4	0.45	0.01
Median	165	99.62	0.04	1.45	16.69	25.25	57.75	0.05	77.55	2.83	53.41	24.9	18.9	0.01	0
Pal- ave	36	99.73	0.04	1.91	45.28	42.68	11.67	0.09	53.52	0.16	11.25	42.43	70.3	0	0
Pal- ole	0	99.8	0.04	22.33	46.22	41.77	11.74	0.08	52.07	0.74	11.02	41.47	14.9	0	0
Pal-vik	37	99.72	0.03	17.89	46.67	41.61	11.3	0.15	52.29	0.23	11.09	41.41	48.2	0.05	0
SL-16	0	99.23	0.07	5.95	50.6	38.1	10.4	0.2	46.5	1.3	9.1	20.2	7.0	1.13	0.01
Mean solid oils	18.25	99.62	0.05	12.02	47.19	41.04	11.28	0.13	51.09	0.61	10.61	40.80	17.4	0.30	0.00
Sd	21.08	0.26	0.02	9.66	2.34	2.01	0.62	0.05	3.13	0.53	1.01	74.8	1.9	0.56	0.01
Median	18	99.75	0.04	11.92	46.44	41.69	11.48	0.12	52.18	0.48	11.05	21.2	23.0	0.03	0

In this study, there was 47% SFAs and 11.57g PUFAs from 100g of the palm oil (Figure 2) and according to Ethiopian national food consumption survey (EPHI 2013), in Addis Ababa there was edible oil consumption of 27.8g/day/person; 12.80g (115.1 calorie) SFAs and 3.22g (4.83% of the total fat calorie) PUFAs (EPHI 2013) which was higher than

WHO's recommendation to be less than 10% and 6-10% of the total fat calorie for SFAs and PUFAs since their excess level are risks to CVD by raising blood cholesterol and LDL levels. Moreover, several studies showed the correlations between high intakes of industrially produced TFAs and increased risk of CHD (Stender et al. 2006; Tarrago-Trani et al. 2006; Willett 2006).

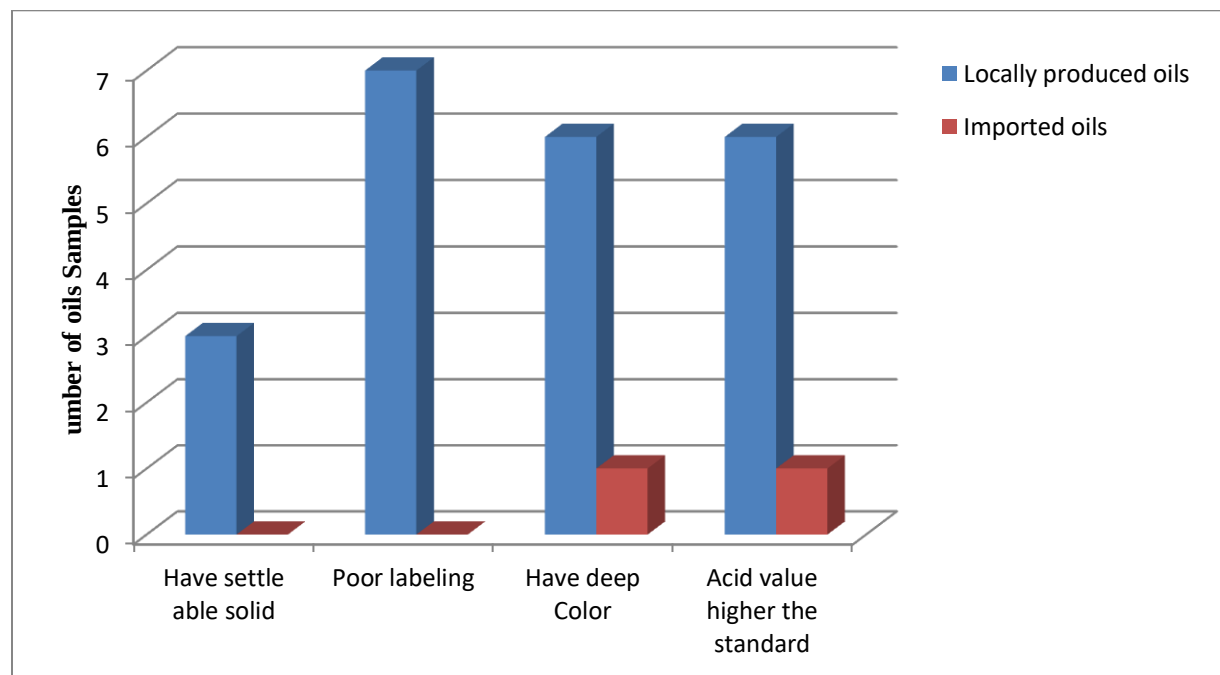


Figure 1: Physicochemical properties of imported and locally produced edible oils

When TFA intake is lowered by 2% (5 g/day), there is a >20% reduction in CHD incidence (Katan 2006; Moss, 2006); foods that contain more than 4g/100g SFAs and TFAs together should not be claimed to be healthy food (Sebastjan et al. 2010). It is recommended to limit TFA consumption less than

1% (approximately 2 g on a 2,000-calorie diet), and saturated fat consumption less than (7%) of the total daily calories (Otunola et al. 2009). Unlike wise, the TFAs constituent of the palm oil in the present study was laid in the acceptable range of daily tolerable limits.

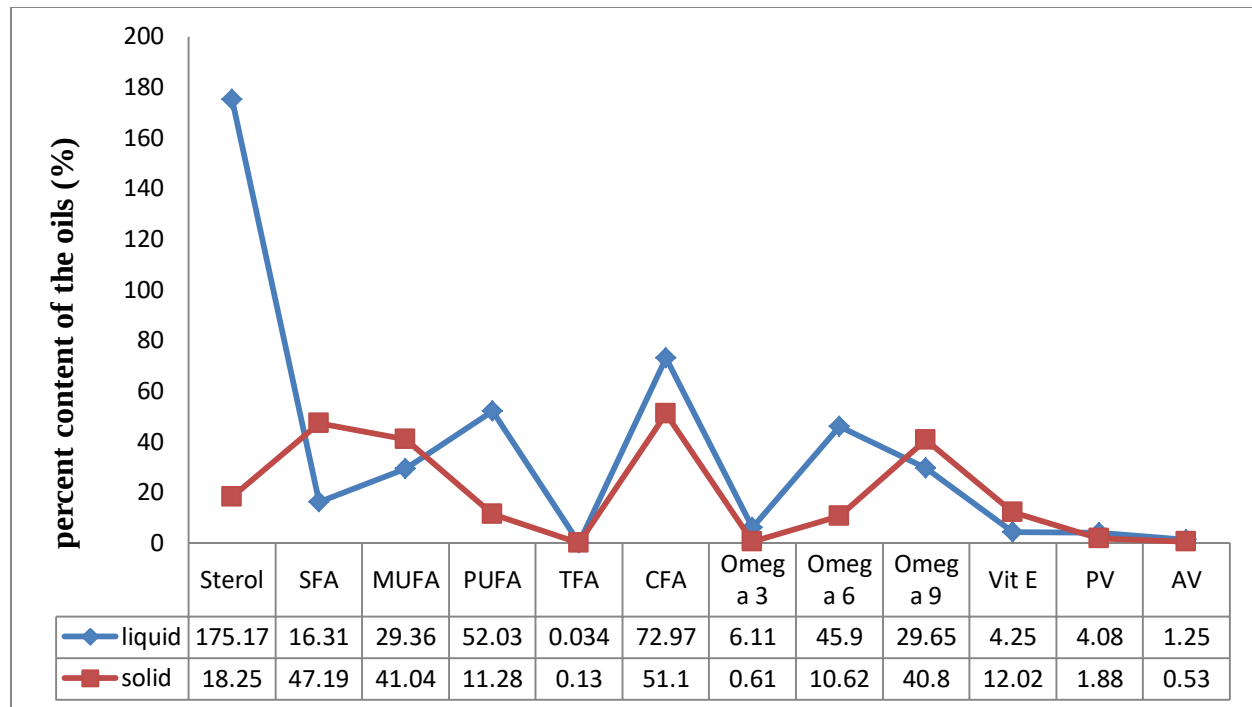


Figure 2: Chemical profiles of solid and liquid oils

Conclusion

Imported oils included in this study were good in labeling; which composed of full information about the product, and they were refined well, clear in appearance and fulfilled oil standard. On other hand, locally produced liquid oils had equivalent quality as imported oils in having sufficient PUFAs content with low saturated FAs, good Omega-6 to Omega-3 ratios, Vitamin A and vitamin E level. However, they did not fulfill labeling requirements and also they need to pass through all the necessary refinery process in the factory; including deacidification, bleaching, refining and deodorization to remove bad odor, unwanted impurities, enhance consumer acceptability and oil shelf life. Palm oils had high Trans, saturated, MUFA and Omega-9 fatty acids with low Omega-3, Omega-6 and cis fatty acids as compared to the liquid vegetable oils. Therefore, it is strongly recommended to use liquid (higher PUFAs) oils in place of solid oils for their many health benefits. As Ethiopia is one of a country producing large amount of oil seeds, perhaps production level of edible oil has to be increased equally to balance the huge demand.

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