Comparative Quality Assessment of Branded and Unbranded Edible Vegetable Oils in Nigeria.

S.A. Chabiri, M. Sc.[1], S.S. Hati, Ph.D.[2*], G.A. Dimari, Ph.D.[3] and V.O. Ogugbuaja, Ph.D. [3]

[1]NAFDAC, Zonal Laboratory Maiduguri, Borno State, Nigeria.
[2]Department of Chemistry, Gombe State University, Gombe State, Nigeria.
[3]Department of Chemistry, University of Maiduguri, Borno State, Nigeria.

*****Email: stevehati@yahoo.com

ABSTRACT

Standard methods of analyses were used to determine, comparatively, the qualities of some branded and unbranded edible vegetable oils (EVOs) in Nigeria. Physical (refractive index and relative density), chemical (iodine and peroxide values), and microbial (mould, *E. coli,* coliform; aerobic mesophillic bacteria counts) parameters were investigated. Results generally showed higher values of the parameters in the unbranded EVOs than in the branded products. However most values fall within the permissible quality limits for edibility as prescribed by WHO. The general quality assessment revealed that processing and dispensing of EVOs under unwholesome sanitary conditions have significant effect on the identity and edibility of oils.

(Keywords: quality, identity, edibility, vegetable oil, industrial, locally processed)

INTRODUCTION

The quality of vegetable oil is a measure of identity and edibility. This is also related to the method of obtaining the oils from the vegetable source (i.e. whether it is virgin oil or cold pressed oil) both obtained without altering the nature of the oil, by mechanical procedures (e.g. expelling or pressing), and the application of heat only. This may be purified by washing with water, settling, filtering, and centrifuging only (Codex, 2005). Certain industrial manufacturing and refining processes may further blend (admixtures of two edible vegetable oils) according to industrial refining and production standard (Agimark, 2002).

Vegetable oil sources include coconut, cotton seed, groundnut, maize germ, mustard seed, palm nut, sesame seed, soya beans, and sunflower seed. According to Codex (2005), edible vegetable oils are "foodstuffs which are composed primarily of glycerides of fatty acids being obtained only from vegetable sources. They may contain small amounts of other lipids such as phosphatides, of unsaponifiable constituents and of free fatty acids naturally present in the fat or oil". They have also been classified (Stanfield, 1986, Anita, 1996; Robert et al., 2003) as lipids, compounds that are insoluble in water but soluble in organic solvents such as trichloromethane, alcohol, etc.

Since, these oils begin to decompose from the moment they are isolated from their natural living environment, with the production of an unpleasant taste and odor over a period of time to form oils often being referred to as rancid. The unpleasant organoleptic characteristics of the rancid vegetable oils are caused by the presence of free fatty acids and by atmospheric oxidation. This is accelerated by the exposure of the vegetable oils to heat, light, moisture, residual natural dyes, pigments and by the presence of transition metals (e.g. copper, nickel and iron) (Ronald and Ronald, 1989).

Therefore, a number of parameters have been used to characterize the identity and edibility of vegetable oils. color, odor, and taste are among the basic parameters. Others include, moisture content, insoluble impurity, iron (Fe), copper (Cu), fatty acid content and antioxidants; acid value (AV), peroxide value (PI)**,** iodine value (IV), refractive index (RI), relative density (RD), and microbial content (Ronald and Ronald, 1989, Williams, 1990, BP, 1993; Prescott et al. 2002).

The microbial content parameters consists of moulds, coliform, *E. coli* and aerobic mesophillic bacteria, etc. (Robertson, 2005; Alo, 2005).

In this work, the term Branded Vegetable Oil (BVO) is used to indicate edible vegetable oils that are produced from registered industries in Nigeria with brand name labels on the product purchased from the open market, while Unbranded Vegetable Oil (UVO) refers to the locally produced and laboratory extracted edible vegetable oil without branding. This was obtained specifically from their raw materials processed in Maiduguri, Nigeria. Thus, this work attempts to make comparative quality assessment of BVO on the basis of effects of industrial processes on the quality of various edible vegetable oils against the locally processed UVOs found in Maiduguri, Nigeria. This will also provide supportive information for routine quality monitoring of both sources of edible vegetable oils that are used as foodstuff.

MATERIALS AND METHODS

Samples and Sampling

Three types of edible vegetable oils (EVOs) were sampled and analyzed in this work. These are:

1. Arachis oil (also called peanut oil; groundnut oil) derived from groundnuts (seeds of *Arachis hypogaea* L.),

2. Soya bean oil derived from soya beans (seeds of *Glycine max* (L.) Merr.);

3. Cottonseed oil derived from the seeds of various cultivated species of *Gossypium spp*.

Fifteen different BVO (five each of the three EVOs) samples were identified statistically from available market data as the most commonly utilized. A monthly, well homogenized, composite from 10 samples of each brand were collected for a period of five months (March 2008-August 2008).

The sampling method was adopted, with slight modification from the standard methods of Williams (1990). The UVO samples were similarly collected within the same period from local sellers of the product at different locations of Maiduguri metropolis, Nigeria. Since they were no branding in this, composites of individual local market sources were maintained. Four major markets were identified and used as sampling points. All samples were collected in a well labeled sterile glass bottles.

Physical and Chemical Analysis

The physical parameters, relative density, and refractive index were determined according to methods described by PORIM (1995) while the chemical parameters, iodine value, and peroxide value were by A.O.C.S. (1997).

A portion of the sample (1.0 ml) was injected into the sample plunger of the densitometer and the reading displayed was then recorded.

A drop of each sample was placed on the sample sensor on the refractometer and readings displayed value was then recorded.

Two grams of each sample was used for the iodine value determination, while 2 g was used for the peroxide value determinations. The results are reported in standard units.

Microbial analysis

Microbial content tests were carried out according to standard methods described by BP (1993) and BASC (1997). Materials used include, plate count agar, PCA (Merck, Germany), violet red bile glucose agar, VRBA (Oxoid Ltd., England), McConkey broth agar, MCA (Merck, Germany), and Sabouraud's dextrose agar, SDA (Merck, Germany). Samples were placed in sterile labeled sterilin bottles and were first diluted with Tween' 80 (polyoxyethylene 20 sorbitoin mono- oleate, Oxoid Ltd., England) in a ratio of 1:10. The diluted samples were then analyzed for the following microbial content mould, Escherichia coli, coliform and total aerobic mesophillic bacteria counts.

Mould count was achieved with the prepared SDA, incubated for 5 days in an oven at controlled temperature of 25^{o}C.

E. coli count was obtained from the VRBA preparations; 1ml of the diluted sample was inoculated and incubated in an inverted position in the oven at controlled temperature of 32^{o}C – 35^{o}C for 2 days.

Coliform count was achieved with the MacConkey agar media, and the inoculated media was allowed to stand in the oven for 2 days at controlled temperature of 37^{o}C.

Aerobic mesophillic bacteria determination was obtained with the PCA media. The inoculated

media was incubated for 2 days in an oven at controlled temperature of 32°C – 35°C.

The resulting growths from respective determinations were identified and recorded accordingly.

Data Analysis

Results obtained from each determination are presented as mean ± SD (standard deviation). Tests for significance in variations were conduct by Student's t-test and analysis of variance (ANOVA) using coupled Microsoft Excel + Analyse-it v2.12 (2007). Variations were considered significant at $p < 0.05$.

RESULTS

Figures 1-4 show a summary result of the physical and chemical analysis of samples of both unbranded and branded EVOs analyzed in this work.

The relative densities, RD (Figure 1) of all UVOs were generally higher than BVOs. The highest value was recorded for UVO (soya bean) with 0.922±0.05, while the least RD was observed in BVO (cotton seed) with 0.915±0.01. The variations were not statistically significant ($p<0.05$), with the exception of UVO (soya bean against groundnut oil).

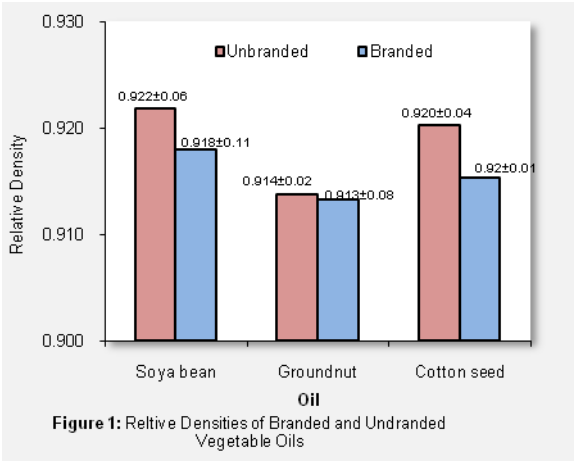

Figure 1: Reltive Densities of Branded and Undranded Vegetable Oils

The result of refractive indices, RI of the EVO samples (Figure 2) indicated that all BVOs showed higher RI values than the UVOs. The highest mean was observed in soya bean (1.474±0.09) while the least was observed in the UVO (groundnut) with 1.463±0.07. The variations in RI were not statistically significant.

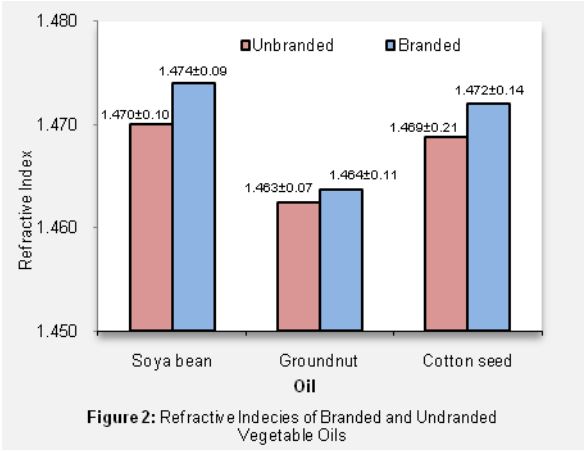

Figure 2: Refractive Indecies of Branded and Undranded Vegetable Oils

The peroxide values, PV of all the UVOs were higher than that of the BVOs (Figure 3), and the variations were statistically significant. The UVO (groundnut) showed the highest value (5.43±1.01mg/kg), while the least value was observed in BVO (soya bean) with 1.95±0.52mg/kg. Cotton showed the highest (3.85±0.67) PV and was significantly higher than its branded counterparts, while the PV of UBO (groundnut) was significantly higher than the UBO (soya bean) only.

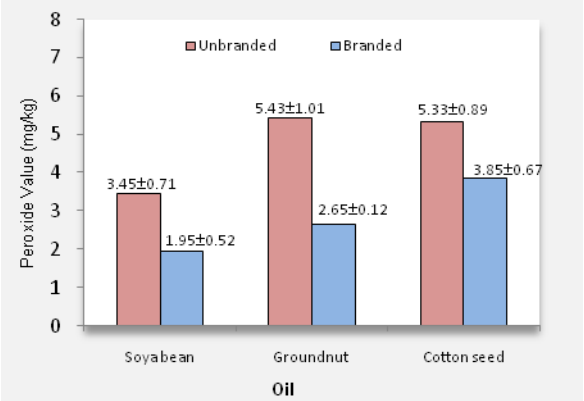

Figure 3: Peroxide Values of Branded and Undranded Vegetable Oils

Figure 4 shows that the iodine values, IV for both UVOs and BVOs were irregular. UVO (soya bean) indicated the highest (128.9±13.34 mg/g) IV, which was significantly higher than all others

with the exception of BVO (soya bean). The least IV was recorded in the BVO (groundnut) with 76.4±3.23 mg/g).

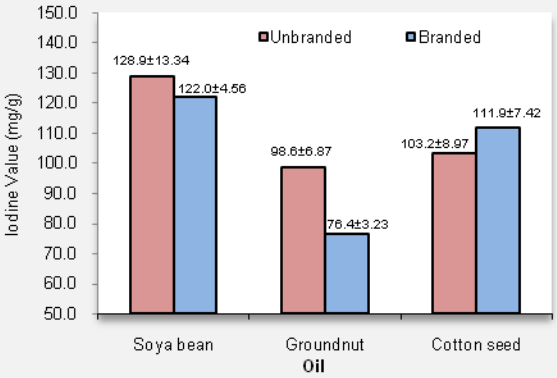

Figure 4: Iodine Values of Branded and Undranded Vegetable Oils

Table 1 shows the results of microbial analysis of both the branded and unbranded EVOs. The result shows that no strain of either *E. coli* or coliform was isolated from all the vegetable oil samples analyzed. However the mould and aerobic mesophillic bacteria counts were found present in all EVO samples analyzed. The result also shows that unbranded vegetable oils analyzed were obviously markedly significant between the unbranded and branded for each type of EVO, while by ANOVA, the within the unbranded group, soya bean oil was significantly lower in both mould and AMB counts. This was similarly observed for the cotton seed oil in the branded group.

Figure 5 shows a composite correlation plots for mould and AMB in each type of oil sample analyzed. The plots show high correlations (r = 0.9) between mould and AMB in all the oil type, with exception of the unbranded groundnut and cotton seed oils, r = 0.8 and r = 0.7, respectively.

DISCUSSION

The RI and RD values of EVOs are physical measures of adulteration of vegetable oils, since different oils have characteristic density and refractive index. Studies have shown that the contamination of vegetable oils with particulate matters and other chemical adulterants such as potassium hydroxide brings chemical reaction with fatty acids of vegetable oils with the production of soap i.e. carboxylic acid ester which alter the optical activity of the vegetable oils and increases the susceptibility of the vegetable oils to become rancid or spoiled (Williams, 1990). However, the results of this study shows correspondence with that reported by Pearson (1987) and were more closely related to the UVO samples.

Peroxide value is a measure of the peroxide contained in the vegetable oil samples, which accumulates during storage. The formation of the peroxide during storage is slow at first in an induction period that may vary from a few weeks to several months according to the particular oil and temperature (Ronald and Ronald, 1989). The result of this work clearly indicated that the UVO had higher PVs, which is very likely in products that do not contain preservatives, either natural or synthetic. The industrial processing of EVO includes preservatives and hence reduces the high PV over time.

Table 1: Results (Mean ± SD) of Microbial Analysis of Unbranded and Branded Edible Vegetable Oils in Nigeria

SAMPLE		Microbial Test (Cfu/ml)			
		COLIFORM	E.coli	MOULD	AEROBIC MESOPHILIC BATERIA (AMB)
Soya bean	Unbranded	-	-	15.00 ± 13.70$^{\Psi}$	75.00 ± 7.24$^{\Psi}$
	Branded	-	-	8.00 ± 5.90	13.50 ± 10.60
Groundnut	Unbranded	-	-	26.00 ± 9.50	115.00 ± 50.00
	Branded	-	-	7.80 ± 10.90	15.00 ± 10.60
Cotton seed	Unbranded	-	-	29.00 ± 3.80	170.00 ± 25.82
	Branded	-	-	2.30 ± 1.30$^{\Psi}$	5.80 ± 2.20$^{\Psi}$

SD = standard deviation, - = (Not detected or isolated), Ψ = significantly lower ($p<0.05$) ANOVA

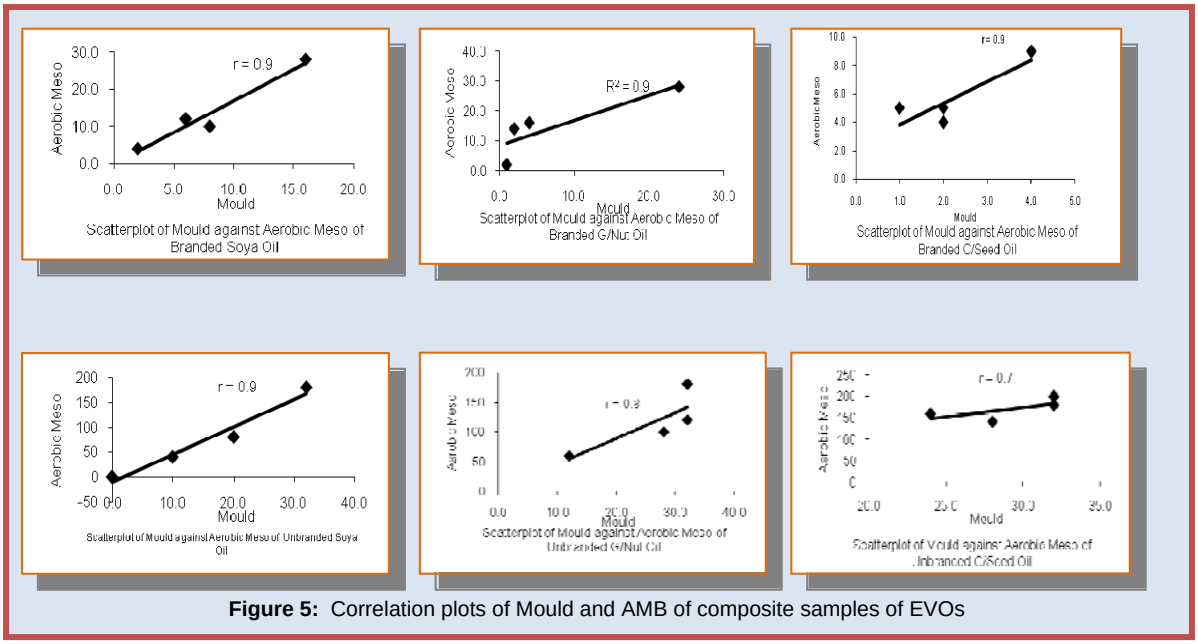

Figure 5: Correlation plots of Mould and AMB of composite samples of EVOs

On the hand, IV measures the degree of unsaturation of a particular vegetable oil. It is the weight of iodine absorbed by 100 parts by weight of the sample. Studies have shown that the greater the degree of un-saturation the higher the iodine value and the greater the liability of the vegetable oil to become rancid by oxidation (Ronald and Ronald, 1989).

Generally vegetable oils do not exhibit significant microbial activity due to their unsuitability for microbial growth; however a few exceptions that are encountered have safety limits that are not supposed to be exceeded (BP, 1993). Hence the results of this study showed indicated negative presence of *E. coli* and coliform. These microbes are usually introduced into the vegetable oils if there is faulty handling from the manufacturers to the final consumer.

Escherichia coli are straight or curved rod like organisms that can grow aerobically by respiring in the presence of oxygen and also under anaerobic conditions by fermenting of various carbohydrates. They have simple nutritional requirements and may move about with the aid of their lateral flagella's. They are oxidases that do not require Na^+ for growth. *E. coli* occurs in lower portion of the intestinal lumen of humans and warm blooded animals where it is part of the normal flora. Some strains have been shown to cause gastroenteritis while others cause urinary tract infections (Hamilton et al. 1987). Coliforms are defined as facultative anaerobic gram-negative, non-sporing rod shaped bacteria. They are a characteristic group of industrial bacteria that are able to survive in non-aquatic environment. Coliforms are brought about by fecal contamination, hence serving as good index of possible food contamination (Dubey and Maheshwar, 2003).

Moulds are multi-cellular eukaryotic organisms (fungi) with many distinctive structural features (Adams and Moss, 1999). They are responsible for the decomposition of many materials synthesizing and excreting large quantities of enzymes into their surrounding environment. They are used industrially for the production of chemicals such as penicillin and enzymes such as proteases, amylases and pectinases and have been shown to be dangerous to humans (Pelczar et al. 2003).

Aerobic mesophillic bacteria are rigid cell vibriod to helical (having less than one twist to having many twist) polar flagella organisms. They are harmless saprophytes and occur in fresh water and marine environment. Only a few exceptions are parasitic and can be pathogenic for humans and animal or for other bacteria. They include *Aquaspirillium, Azospirillium, Oceanospirillium, Campylobacter, Bdellovibrio,* etc. The pathogenic

aerobic mesophillic bacteria have been shown to cause diarrhea in humans (Pelczar et al. 2003).

Other possible sources could be from atmospheric deposition or contaminated arable soil to which large amount of phosphate containing fertilizers have been applied (UNEP, 1989).

Results of the correlation analysis between mould and aerobic mesophillic bacterial content of all the branded and unbranded samples of the vegetable oils analyzed showed a markedly positive correlation as revealed on the scatter plots on Figure 5. These seemingly marked dependence or association of mould on aerobic mesophillic bacteria can be attributed to environmental factors such as temperature, relative humidity and the conducive breeding environment for growth of these micro organism provided by the oil which may also be due to poor handling of the product from the producer to the final consumer (Prescott et al. 2002).

The high microbial content of the unbranded vegetable oil can be attributed to the contamination of matured oilseeds and nuts which, when harvested and stored over a long period of time, are susceptible to spoilage and the absence of industrial purification processes especially at the point of retailing which leads to the possible increase in moisture content of the vegetable oils and the corresponding rise in levels of free fatty acids which aids the growth of the lipolytic mould species such as *A. niger*, *A. tamari, penicillium, paecilomyces* and *Rhizopus species* (Adams and Moss, 1999). The exposure of the samples to the atmosphere also predisposes it to contamination with aerobic mesophillic bacteria like *Aquaspirillum, Azospirillium, Oceanospirillium, Campylobacter* and *Bdellovibrio* which make up the atmospheric microbial load and can easily contaminate the samples when left in the open (Pelczar et al., 2003).

The aerobic mesophillic bacteria are capable of producing the enzyme lipase, the lipase which catalyses the breakdown of organic substrate with the production of peroxide oxygen hence, making the vegetable oils rancid. This probably accounts for the high peroxide value and iodine value recorded in the unbranded vegetable oils (Williams, 1990). The presence of mould in the samples causes the formation of mycotoxin with the various mould species exhibiting strong lipolytic activity, generating free fatty acids and may undergo oxidation to form products which leads to rancidity and spoilage of the oils (Adams and Moss, 1999).

In Nigeria, the recommendation by WHO/FAO (Allen et al., 2005) and supporting regulatory bodies to fortify vegetable oils, especially with vitamin A is being enforced to improve the quality of EVOs (Omolayole, 2005). This and many other additives to industrial productions of EVOs can be responsible for the variations observed. However variations are also observed as described by Codex (2005), that samples falling within the appropriate ranges specified are regarded in compliance with the standard, though supplementary criteria, for example national geographical and/or climatic variations, may be considered, as necessary, to confirm that a sample is in compliance with the Standard.

Generally, the result of this study falls within the standard prescribed by WHO/FAO for edibility.

CONCLUSION

This research has been able to establish that all the branded vegetable oils analyzed show good physical and chemical quality of identity with minimal microbial contamination, while the unbranded vegetable oils on the other hand showed increased microbial content (mould and aerobic mesophillic bacteria, although these are within the WHO specified limits). From these findings, the emphasis is therefore laid on the consumption of branded vegetable oils rather than unbranded vegetable oils. If the fight against malnutrition and micronutrient deficiency is to succeed in Nigeria and other developing nations, efforts should further be geared towards promoting good manufacturing practices.

The general quality assessment revealed that processing and dispensing of EVOs under unwholesome sanitary conditions have significant effect on the identity and edibility of oils.

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ABOUT THE AUTHORS

Chabiri, SA, M.Sc., is an Analyst at the Quality Control Laboratory, NAFDAC Zonal Laboratory, Maiduguri, Nigeria with research interests in food, drug, and chemical products quality assessment (e-mail samchabiri@yahoo.co.uk;. Tel: +234-08065703091).

Hati, SS, Ph.D., is a Lecturer in Analytical Chemistry at the Department of Chemistry, Gombe State University, P.M.B. 127, Gombe Nigeria (e-mail stevehati@yahoo.com Tel: +234-08057542206) Dr. Hati's research interests are in pollution prevention and control and analytical methods development.

Dimari, G. A., Ph.D. is a Senior Lecturer in Analytical Chemistry, Department of Chemistry, University of Maiduguri, P.M.B. 1069, Maiduguri, Nigeria (e-mail: dimarigoni@yahoo.com; Tel: +234-8030748618. Dr. Dimari's research interests are in atmospheric air pollution monitoring and analytical method development.

Ogugbuaja, V.O., Ph.D. is a Professor of Analytical Chemistry in the Department of Chemistry, University of Maiduguri, P.M.B. 1069, Maiduguri, Nigeria (e-mail: victotin@yahoo.com; Tel: +234-8057612913). Dr. Ogugbuaja's research interests are in pollution prevention and control and nuclear analytical methods.

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