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THE CHANGE IN PHYSICO-CHEMICAL PROPERTIES OF BLENDED OILS OF PALM ORIGIN WITH SOYABEAN OIL

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ABSTRACT

The wax content of some vegetable oil brands and the effect of blending soyabeans oil with oils of palm origin have been investigated. The brands of vegetable oil namely: KF-KOFA, soyabean oil, MZ – MAZOLA, maize (corn) oil, SN – SUNOLA, cottonseed oil, FS – FERDINAND SUPER, palm oil, FT – FERDINAND TRUST, palm kernel oil and TK – TUREY, palm oil were used for various tests. The physico chemical properties considered were (i) cold stand, (ii) cloud point, (iii) saponification number (iv) iodine number. KF – KOFA, soyabean oil had the highest wax content and with a value of 6.44ppm while SN – SUNOLA, cottonseed oil had the least and with a value of 3.44ppm. The seed oils, except for SN – SUNOLA, cottonseed oil, had higher wax content than the oils of palm origin.

The physico-chemical properties of the oils of palm origin were changed. The blending of oils of palm origin with soyabean oil had an inhibitory effect on the cloud formation of oils of palm origin as the cloud points reduced from 15 – 17°C for FS pure sample, to 9 – 10°C for KF/FS blend and from 21 – 23°C for FT, pure sample, to 13 – 15°C for KF/FT blend and from 18 – 20°C for TK, pure sample, to 11 – 13°C for KF/TK blend. The blending increased the carbon chain length and also the degree of unsaturation of the oils under investigation. The saponification numbers reduced from 243.41 for FS pure sample, to 217.38 for KF/FS blend and from 278.26 for FT, pure sample, to 220.19 for KF/FT blend and also from 328.01 for TK, pure sample, to 263.14 for KF/TK blend. The iodine numbers increased from 34.26 for FS, pure sample, to 84.43 for KF/FS blend and from 18.36 for FT pure sample, to 81.76 for KF.FT blend and also from 34.26 for TK, pure sample, to 85.13 for KF.TK blend.

KEYWORDS: Vegetable oil, Crystallization, Wax, Crystal Inhibitor, Blending.

INTRODUCTION

Vegetable oil is from vegetable sources such as palm fruit, palm kernel, peanut, corn, cottonseed and soyabean. It is composed of tri-blycerides of stearic, palmitic, lauric or any other fatty acid and very small amount of non-glyceride materials, such as Lecithins, Cephalins especially those from oil seeds, sterols, hydrocarbons, waxes and some free fatty alcohols. B-carotenes, Chlorophyll and Tocopherol (Vit. E) are also present in fats and oils. (*Meyer, 1960; Hilditch, 195; Neumunz, 1978; Dollear, 1958; Sullivan, 1976*). Fatty acids are organic acids and are often mono carboxylic acids. They are homologues of acetic acid with 12 – 20 carbon atoms in the chain. Most of the acids are straight-chained and except for the low molecular weight acids, fatty acids are exclusively composed of acids with an even number of carbon atoms. The common fatty acids normally contain from C_{12} to C_{24} (*Kariston et al, 1975*).

The fatty acids differ in chemical composition. Some are saturated e.g. Butyric, Palmitic, Stearic, Lauric, Myritic, Capric, Caprilic and rachidic acids while some others are unsaturated e.g. Oleic, Linoleic, Elaidic, Palmitoleic, Linolenic and Arachidonic acids. Generally speaking, the saturated fatty acids are called fats and are usually solids at atmospheric temperature while the unsaturated fatty acids are called oils and are usually liquids at atmospheric temperature while the unsaturated fatty acids are called oils and are usually liquids at atmospheric temperature (*Karlson et al, 1975*). Presently in Nigeria, the principal edible oils sold in the markets are refined palm/palm kernel, peanut, soyabean, cottonseed and corn oils. There are also the unrefined peanut and palm oils sold in the market. Palm oil consists mainly of a balanced mixture of saturated fatty acids, which constitute the yellow/orange solid fraction, and unsaturated fatty acids, which constitute the reddish liquid fraction (*Loncin et al, 1970, RMRDC, 1988*). The fatty acids of palm oil are essentially 45% palmitic acids and 55% mixed 18 carbon acids (*Loncin et al, 1970*). Palm oil is constituted of about 52.1% saturated fatty acids. Palm kernel oil has a high content of lauric and myristic acids and is constituted of about 84.2% saturated fatty acids (*Ashland, 1969*). Peanut oil has high oleic and Linoleic acids content and is constituted of about 84.2% saturated fatty acids (*Ashland, 1969*). Peanut oil has high oleic and Linoleic acids content and is constituted of about 81.9% of unsaturated fatty acids. Soyabean oil contains small quantities of wax and other non-glycerides consisting mainly of Lecithins and Cephalins. It consists of mainly Linoleic acid. It is constituted of about 86% of unsaturated fatty acids. Cottonseed oil contains small quantities of phyophatides and other non-glyceride substances. It is constituted of about 70.5% of unsaturated fatty acids. Corn oil contains higher percentage of oleic and Linoleic acids than cottonseed oil and other non-glyceride materials. However, it contains little quantity of wax. It is constituted of about 86.1% of unsaturated fatty acids (*Ashland, 1969*).

It is common with some of these oils, especially those of palm origin to form cloud (or crystallize) at ordinary temperature while some others from oil seeds remain clearly liquid at ordinary temperature or even when chilled. The cloudiness in oils is attributed to the presence of wax and/or some saturated glycerides with high molecular weight, and of limited solubility in the liquid fraction of the oil. Also, the presence of short chain fatty acids at levels of about 50% makes the soil solid at slightly below room temperature. Wax is not harmful but the formation of cloudy precipitates in the oil at ordinary temperature makes it unacceptable in oils especially to the commercial producer of mayonnaise who needs oils that would not solidify on chilling. Wax or solid fats are not acceptable in salad oils.

This paper describes the wax content of palm, palm kernel, soyabean, corn and cottonseed oils. It also describes the effect of blending of oils of palm origin with soyabean oil on some of the physico-chemical properties of oil of palm origin.

MATERIALS

The vegetable oil brands used for the tests were bought at retail shops at Aba, Abia State, Owerri, Imo State, Onitsha, Anambra State and Abuja, FCT.

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The vegetable oil brands are as follows:

1. KF–KOFA,soya bean oil
2. SN–SUNOLA, Cotton seed oil
3. MZ–MAZOLA,Maizeoil(cornoil)
4. TK–TURKEY,Palmoil
5. FT–FERDINANDTRUST,Palm kernel oil
6. FS – FERDINAND SUPER, Palm oil

METHODS

The tests carried out on the oil samples include (i) cold stand (ii) cloud point, (iii) wax content (iv) saponification number (v) iodine number. Apart from wax content, other test were carried out before and after blending soyabean oil with palm/palm kernel oils. For the blended samples, equal volumes of the soyabean oil and the palm/palm kernel oils were used for the tests.

(i) **Cold Stand:** 40mls of the sample were placed in a conical flask, corked and kept in the refrigerator for 6 hours and observed for cloud formation.

(ii) **Cloud Point:** 10mls of the oil sampled were placed in a test tube and immersed in ice ships, contained in a beaker, such that the length of the oil in the tube was completely covered by the ice chips and water. The cloud points of soyabean oil, corn oil and cottonseed oil were determined in the micro freezer. The oil samples were observed for cloud formation at every 3°C fall in the thermometer temperature. The temperature at which a slight cloud was observed in the oil sample was taken as the cloud point.

(iii) **Saponification Number:** The conventional titrimetric method was used (*Firestone, 1990*).

(iv) **Iodine Number:** The conventional WIJ's method was used (*JAOAC, 1965*)

(v) **Wax Content (PPM):** The Turbidimetric (Nephelometric Turbidity unit) method was used (*Morrison and Russel 1982*). Turbidity is the expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. The scattering and absorption is caused by the interaction of light with particles suspended in the sample media, for example, suspended solids including slit, clay, organic matter, microbes and other fine insoluble particles Particles interfering with light transmittance caused the sample to take on a hazy or cloudy appearance (*HACH, 1992*).

Optically, black particles such as those of activated carbon may absorb light and effectively increase turbidity measurement. The particulates that cause turbidity may be those detrimental to the end user, or some vital ingredients of a product. In either case, turbidity can be used as a quality control measure to monitor the efficiency of the treatment or manufacturing processes.

Today, turbidity is usually measured by applying Nephelometry, a technique that measures the level of light scattered by particles at right angles to the light beam. When light hits a particle, the energy scatters in all directions. The scattered light level is proportional to the particulate concentrations and is measured by an electronic photo-detector (*Vanous, 1978*). The turbidimeter (the instrument used in the measurement of turbidity) has a very wide application. It has been applied to water/waste treatment, microbiology research, determination of sulphates, metal plating baths, non-reactive silica monitoring, iron particulate detection, petrochemical (*HACH, 1992*).

The application has also been extended to quality control for foods e.g. cheese, beverage manufacturing and also the monitoring of the production of corn and soyabean oils. It has been used to monitor the phosphorus content in oil as to minimize the derivatives that may lead to off-flavour precursors and oxidative instability (*Sinram, 1986*). The application has also been extended to the wax determination in vegetables oils.

WAX DETERMINATION

A 50:50 mixture of the oil sample and acetone was made and placed in the refrigerator for 5 minutes. The turbidity in Nephelometric Turbidity Unit (NTU) was then read. The wax content was then calculated from the equation (*Morrison and Russel, 1992*).

$$Y = 1.68 + 0.56\,(x) + 1.3 \times 10^{-5} \times 2$$

$$Y = \text{PPM Wax}$$

$$X = \text{Turbidity in NTU}$$

RESULTS AND DISCUSSION

Table 1: Cold stand for pure samples

SAMPLES	OBSERVATION
KF – KOFA, Soyabean oil	Did not solidify and remain liquid and clear
SN – SUNOLA, Cottonseed oil	Froze but melted within 1-2 minutes it was brought out of the refrigerator
MZ – MAZOLA, Maize (corn) oil	Did not freeze
TK – TURKEY, Palm oil	Solidified completely and remained frozen for 10-12hrs after being brought out of the refrigerator
FT-FERDINAND TRUST, Palm kernel oil	Solidified completely and remained frozen for 18-20hrs after being brought out of the refrigerator
FS – FERDINAND SUPER, Palm oil	Solidified completely but melted in about 10-15 minutes on being brought out of the refrigerator

Table 2: Cold stand for blended samples

BLENDED SAMPLES	OBSERVATION
KF – KOFA, Soyabean oil + Ferdinand Super, palm oil)	Solidified but melted immediately it was brought out of the refrigerator. (Less than 1 minute)
KF + FT, (Soyabean oil + Ferdinand Trust, palm kernel oil)	Solidified but took a little longer time to melt after being brought out of the refrigerator. (More than 3 minutes).
KF + TK, (Soyabean oil + Turkey, palm oil)	Solidified but took a little longer time to melt after being brought out of the refrigerator (2-3minutes)

Table 3: Cloud point for pure samples

SAMPLES	CLOUD POINT (^oC)
KF – KOFA, Soyabean oil	0 to -3
SN – SUNOLA, Cottonseed oil	1 to -2
MZ – MAZOLA, Maize (corn) oil	-4 to -6
TK – TURKEY, Palm oil	18 to 20
FT-FERDINAND TRUST, Palm kernel oil	21 to 23
FS – FERDINAND SUPER, Palm oil	15 to 17

Table 4: Cloud point for blended samples

BLENDED SAMPLES	OBSERVATION
KF + KOFA, Soyabean oil + Ferdinand Super, palm oil)	9 to 11
KF + FT, (Soyabean oil + Ferdinand Trust, palm kernel oil)	13 to 15
KF - TK, (Soyabean oil + Turkey palm oil)	11 to 13

Table 5: Wax content

SAMPLES	TURBIDITY (NTU)	WAX CONTENT (ppm)
KF – KOFA, Soyabean oil	8.50	6.44
SN – SUNOLA, Cottonseed oil	3.14	3.44
MZ – MAZOLA, Maize (corn) oil	7.50	5.88
TK – TURKEY, Palm oil	4.93	4.44
FT-FERDINAND TRUST, Palm kernel oil	5.60	4.82
FS – FERDINAND SUPER, Palm oil	3.84	3.83

Table 6: Saponification number for pure samples

SAMPLES	SAPONIFICATION NUMBER
KF – KOFA, Soyabean oil	223.84
SN – SUNOLA, Cottonseed oil	218.79
MZ – MAZOLA, Maize (corn) oil	232.40
TK – TURKEY, Palm oil	328.26
FT-FERDINAND TRUST, Palm kernel oil	278.26
FS – FERDINAND SUPER, Palm oil	243.41

Table 7: Saponification number for blended samples

BLENDED SAMPLES	SAPONIFICATION NUMBER
KF + KOFA, Soyabean oil + Ferdinand Super, palm oil)	220.19
KF + FT, (Soyabean oil + Ferdinand Trust, palm kernel oil)	217.38
KF - TK, (Soyabean oil + Turkey palm oil)	263.14

Table 8: Iodine number for pure samples

SAMPLES	IODINE NUMBER
KF – KOFA, Soyabean oil	84.30
SN – SUNOLA, Cottonseed oil	79.90
MZ – MAZOLA, Maize (corn) oil	95.17
TK – TURKEY, Palm oil	34.26
FT-FERDINAND TRUST, Palm kernel oil	18.33
FS – FERDINAND SUPER, Palm oil	34.26

Table 9: Iodine number for blended samples

BLENDED SAMPLES	IODINE NUMBER
KF + KOFA, Soyabean oil + Ferdinand Super, palm oil)	81.76
KF + FT, (Soyabean oil + Ferdinand Trust, palm kernel oil)	84.43
KF - TK, (Soyabean oil + Turkey palm oil)	85.13

The Saponification Values of the oil samples indicate that oils of palm origin are composed of shorter chain fatty acids than the oils from oil seeds (Table 6). The Iodine Values also indicate that the oils from oil seeds are more unsaturated than the oils of palm origin (Table 8). From the Saponification and Iodine values of the blended oil samples, there is a reduction in the saponification values (Table 7) and an appreciable increase in the Iodine values of the blended oils of palm origin (Table 9). It could be said that blending of oils of palm origin with soyabean (seed oil) increases the average molecular weight and the unsaturation of oils of palm origin. Therefore, this tendency to increase the chain length and with the resultant increase in unsaturation of oils of palm origin affects the solidification of oils of palm origin.

There is a decrease in the cloud points of the blended oils of palm origin (Tables 3 and 4). The cold stand also indicates a suppression or inhibition of the formation of permanent clouds (Xtals) in the blended oils of palm origin (Tables 1 and 2). Now, the cause of cloudiness (Freezing) of the oils of palm origin at normal atmospheric temperature is attributed to the presence of wax and/or saturated fatty acids, but the observed characteristics of KF (soyabean oil), and with regards to its wax content, are surprising. KF (Soyabean oil) as well as oils from the other oil seeds remained clear after the cold stand while oils of palm origin solidified in the refrigerator (Table 1). Again in the cloud point test, KF (Soyabean oil) formed very minute clouds at very low temperature after a very long time while the oils of palm origin formed more permanent clouds in a very short time, about 2 to 3 minutes.

Naturally, soyabean oil (KF) contains wax and thus, was expected to solidify because of the wax, but KF did not solidify under atmospheric temperature, even at refrigerator temperature while the oil samples of palm origin solidified. This may seem to indicate that the oils of palm origin contain more wax than KF (Soyabean oil) But in the turbidimetric wax determination KF was observed to contain more wax than the oils of palm origin (Table 5) With these results, it is therefore surprising to note that KF contains more wax than the oil samples of palm origin yet KF did not solidify at atmospheric temperature (even at refrigerator temperature) while the oils of palm origin contains less wax and yet they solidified at atmospheric temperature and also at refrigerator temperature. It should also be noted that soyabean oil is a natural and commercial source of lecithin. Lecithin is a triglyceride with one fatty acid replaced by a phosphoric ester of chlorine or ethanolamine. It is waxy and soluble in fats and oils. Lecithin acts as a crystal inhibitor, and also as an emulsifier. It is usually an additive to oils as crystal inhibitor, and was the first crystal inhibitor used by oil processors (*Nash et al, 1967*). Other chemical compounds develop and approved for use in controlling crystal growth are oxystearin and a polyglycerol ester of mixed fatty acids.

Crystal inhibitors are used to extend the cold test of oils. However, a poorly winterized oil cannot be made into a good salad oil by the addition of these crystal inhibitors. Therefore, the observed characteristics of KF in the cold and cloud point tests could be explained in terms of its content of crystal inhibitors. Again, the average molecular weight of the fatty acid composition of oils could also be a factor in the solidification of the oils of palm origin. This could explain the result of the cold test analysis for blended and pure oil samples. Thus, it could be said that oils with high average molecular weight fatty acids do not solidify at atmospheric temperature.

CONCLUSION

Blending of oils of palm origin with soyabean oil depresses or inhibits either cloud formation or crystallization of oils of palm origin at atmospheric or even at low temperature.

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