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Characterization of fluted pumpkin (*telfiariaoccidentalis* hook f) seeds oil emulsion

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ABSTRACT

Oil-in-water emulsions were produced from the oil extracts as well as with olive oil. Some of the properties characterized were droplets size concentration and distribution which ranged from 28µm to 142µm. Visible layer boundaries of emulsion rose from 0.00mm to 3mm. Emulsion stability of samples were 38.46% (olive oil), 35.71% (n-hexane oil) and 34.97% (petroleum ether oil). Emulsion capacity of olive oil was 35.7%, while that of n-hexane and petroleum ether oil were 32.1% and30.4% respectively. Emulsion stability indices for olive oil, n-hexane and petroleum ether extracts oil were 0.65±0.02, 0.71±0.18, and 0.69±0.12 respectively. Microbial contamination was 2.67x10^{4} *cells/ml for olive oil emulsion, 2.67x10*^{5} *cells/ml from-hexane and petroleum ether oil emulsion. These results indicate potential and good emulsion stability. It is suggested that fluted pumpkin seed oil may be used in emulsion production due to its great stability.*

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I. INTRODUCTION

Emulsion consists of two or more completely or partially immiscible liquids, such as fat or oil and water, where one liquid is dispersed in the other in the form of droplets (Dickinson, 1992). At the interface of each droplet, the molecules of the two liquids are in direct contact with each other, which is thermodynamically highly unfavorable. Although the entropy of the system increases as the emulsion is homogenized (increased entropy of mixing), this effect is not sufficient to balance the unfavorable enthalpy increase that arises because of the contact between hydrophilic and hydrophobic molecules (Hiemenz and Rajagalopan, 1997). The system has the tendency to separate and attain a configuration in which the contact area between the two phases, and subsequently the free energy of the system, is minimal. Surfactant molecules that adsorb at liquid-liquid interfaces can decrease the enthalpy contribution to the overall free energy increase and thus reduce the tendency of the emulsion to destabilize (Weiss, 1999). However, surfactant molecules can reduce the tendency of an emulsion to destabilize; they are not able to completely prevent it from a thermodynamic perspective, and emulsion destabilization is inevitable. Fortunately, emulsion breakdown does not occur instantaneously. A finite time is required for droplets to collide, merge, coalesce or grow, and eventually phase separate. If this process occurs over a long period of time that exceeds the intended life-time of the product, the emulsion is considered to be kinetically stable (Robins, 2000).

In the broadest sense, stability of emulsions is defined as maintenance of an initial state that was attained after homogenization of the two (or more) liquids (Sjoblom, 1996). The initial state of the emulsion can be defined by a set of internal parameters (Peña, 2004). The primary parameters used to describe the state of an emulsion are droplet size distribution and concentration, since the bulk properties of emulsions such as colour, texture, and taste are primarily a function of these two colloidal parameters (McClements, 1999). In selected cases it may be necessary to include additional parameters such as pH and microbial load to further define the initial state of the emulsion.The lifetime of emulsions is a function of various extrinsic parameters. During production, transport, and storage, emulsions are subject to a variety of fluctuating external stresses that can alter the initial state of the system and eventually cause the emulsion to become unstable. The goal of any emulsion stability test should be to closely model stress conditions encountered in an actual application setting. Most emulsion stability tests focus on the measurement of droplet size as a function of storage time at a specific temperature. Emulsions may be subject to a variety of chemical, physical, and microbiological stresses in addition to temperature (Miller, 1988). All these stresses can have profound effects on the macroscopic and colloidal properties of the emulsions (Sjoblom, 1996) and (Jing, *et al* (2006). It should be noted that measurements of bulk properties such as rheology and color as a function of time can be used to determine the stability of emulsions as well (Serra and Casamitjana, 1998); However, interpreting bulk emulsion properties to obtain information about changes on the colloidal level is much more difficult than measuring colloidal properties to predict changes on the macroscopic level.

II. METHODOLOGYS

Plants materials

Fluted Pumpkin seeds: The fluted pumpkin (*Telfairiaoccidentalis* Hook F) seed used for this research were purchase from Nsukka area of Enugu State, Nigeria, and identified by Mr O. U.Ozioko of Bioresource Development and Conservation Programme (BDCP) Resource Centre, Nsukka.

Chemicals

All chemicals used were of analytical grade and were products of British Drug House (BDH) Chemical limited, Poole England.

Statistical analysis

All investigations were carried out in triplicate and data obtained were presented as mean ± standard deviation using descriptive statistics. Student T – test was used to compare mean variance. Significance was accepted at $p<0.05$ level using SPSS v16.

III. RESULT

Characterization of emulsions

The results of the characterization of emulsions are shown in table 1.Emulsion stability index; emulsion capacity and emulsion stability do not differ significantly with olive oil emulsion.

Table 1 Characterization of emulsions

oil samples	ESI	EC (%)	ES (%)
olive oil	0.65±0.02	35.7	38.46
Fluted pumpkin oil n-hexane extracts	0.71±0.18	32.1	35.71
Fluted pumpkin oil, pet ether extracts	0.69±0.12	30.4	34.97

Result of droplet size of fluted pumpkin seed oil emulsions stabilized by 20% (w/v) tween 80

Table 2 show the result of emulsion droplet sizes. The droplet size of all the emulsions ranges from 28 µm to 100µm.

Table 2 Droplets size of fluted pumpkin seed oil emulsions stabilized by 20% (w/v) tween 80

Droplets size of fluted pumpkin seed oil emulsions (n-hexane extract (µm)	**Droplets size of fluted pumpkin seed oil emulsions (petroleum ether extract (µm)**	**Droplets size of olive oil emulsions (µm) (standaed reference oil).**
48	**38**	**28**
49	**47**	
60	**77**	**53**
71	**88**	**59**
89	**97**	**71**
102	**100**	**82**
142	**137**	**100**

Time dependent height increase of the visible creaming layer boundary of olive oil emulsion.

Figure 1 shows the height increase of the visible layer boundary of olive oil emulsions at 3mm and a delay time of 199 minutes.

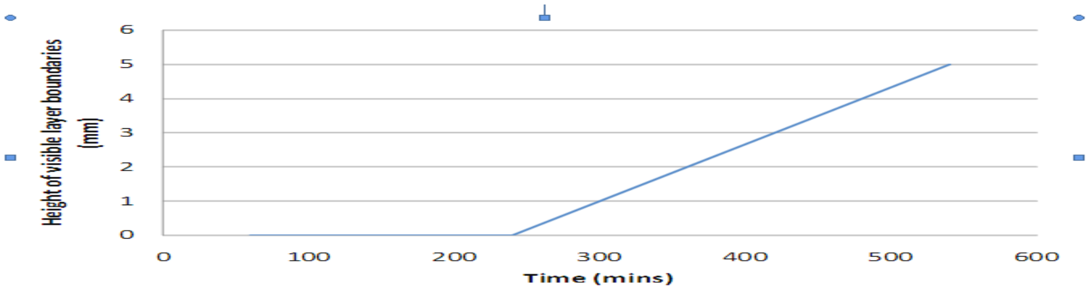

Figure 1 Time dependent height increase of the visible creaming layer boundary of olive oil emulsion.

Time dependent height increase of the visible creaming layer boundary of oil extracted with petroleum ether

Figure 2 shows that the creaming layer boundary of emulsion produced from fluted pumpkin seed oil extracted with petroleum ether had a delay time of 250 munites and height increase of 4mm.

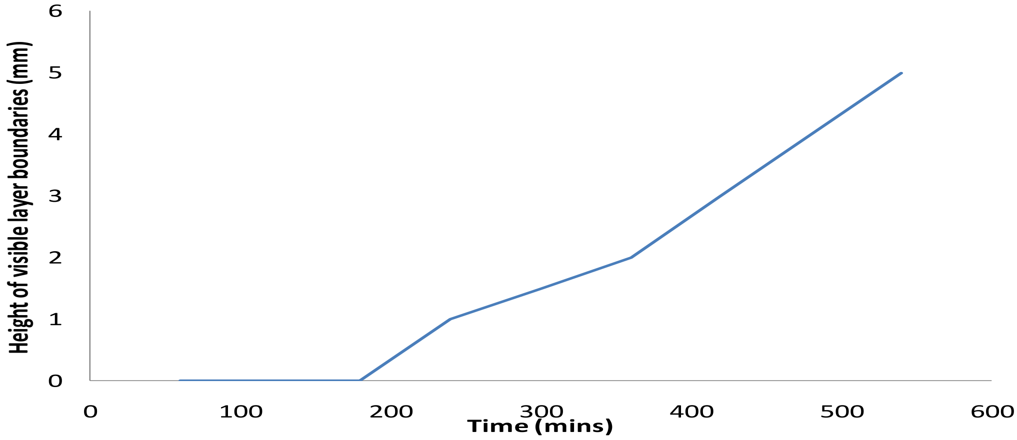

Figure 2 Time dependent height increase of the visible creaming layer boundary of oil extracted with petroleum ether.

Time dependent height increase of the visible creaming layer boundary of oil extracted with n-hexane

The Figure 3 shows the creaming layer boundary of emulsion produced from fluted pumpkin seed oil extracted with n-hexane. The result showed that the emulsion had taken a short time to sediment or cream that is two hundred minutes to cream to three millimeters height.

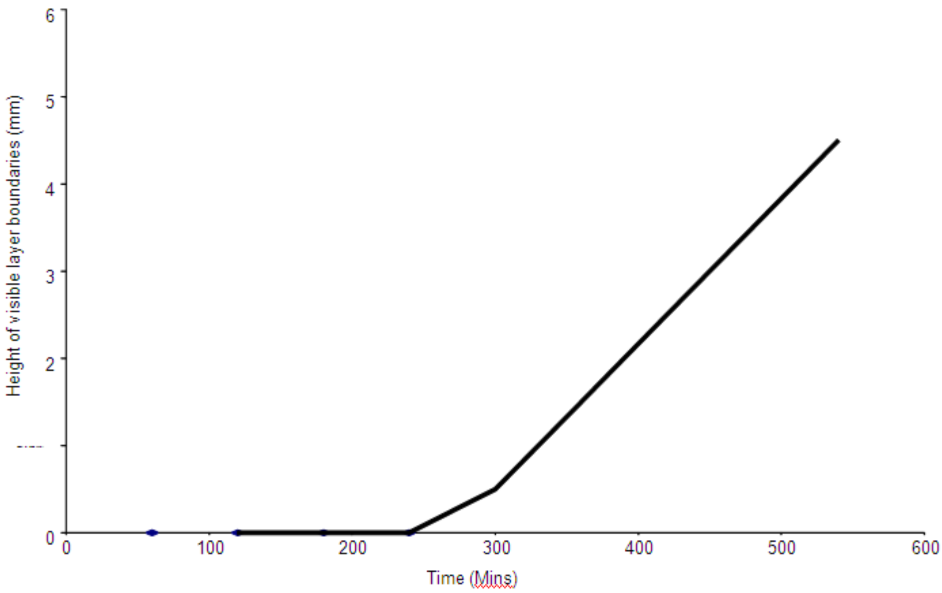

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Figure 3 Time dependent height increase of the visible creaming layer boundary of oil extracted with n-hexane.

Time dependent height increase of the visible creaming layers of olive oil, oil extracted with n-hexane and petroleum ether emulsions.

Figure 4 shows creaming layer boundary of emulsion produced from fluted pumpkin seed oil extracted with petroleum ether, n-hexane and olive oil emulsion. The result showed that the emulsion had taken both short and long time to sediment or cream. The average delay time is 200 minutes with a height increase of 4mm.

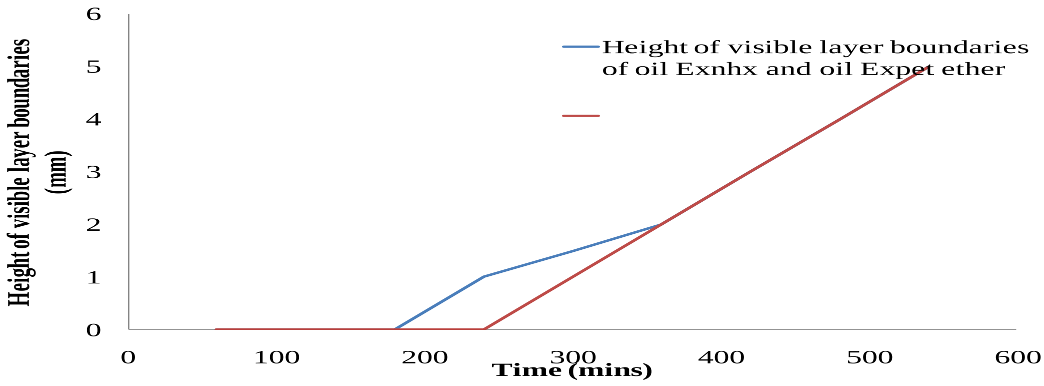

Figure 4 Time dependent height increase of the visible creaming layers of olive oil, oil extracted with n-hexane and petroleum ether.

Density of olive oil emulsion at 1 bar atmospheric pressure as a function of temperature.

Figure 5 shows the density of olive oil emulsion at 1 bar atmospheric pressure as a function of temperature. The figure showed that the density of emulsion decreases as the temperature is increased. Increased temperature at 60°C to 70°C destabilized the emulsion completely.

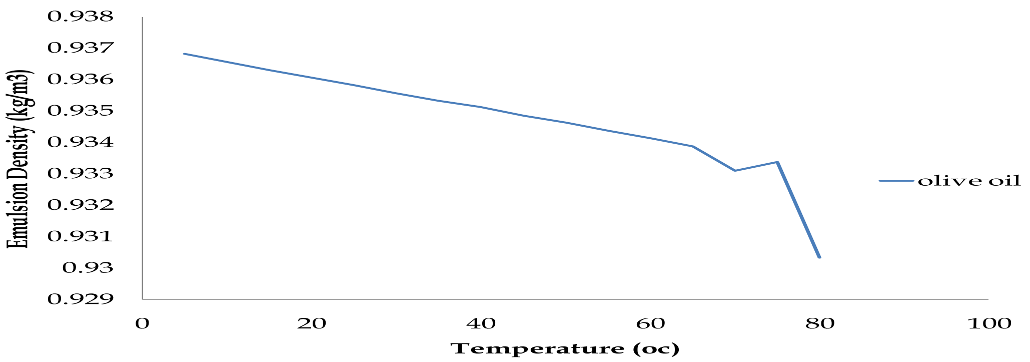

Figure 5 Density of Olive Oil emulsion at 1 bar atmospheric pressure as a function of temperature.

Density of fluted pumpkin seed oil emulsion extracted with petroleum ether at 1 bar atmospheric pressure as a function of temperature

Figure 6 shows the density of fluted pumpkin seed oil emulsion extracted with petroleum ether at 1 bar atmospheric pressure as a function of temperature. The figure showed that the density of emulsion decreases as the temperature is increased. At high temperature 60°C to 80°C, the emulsion is destabilized.

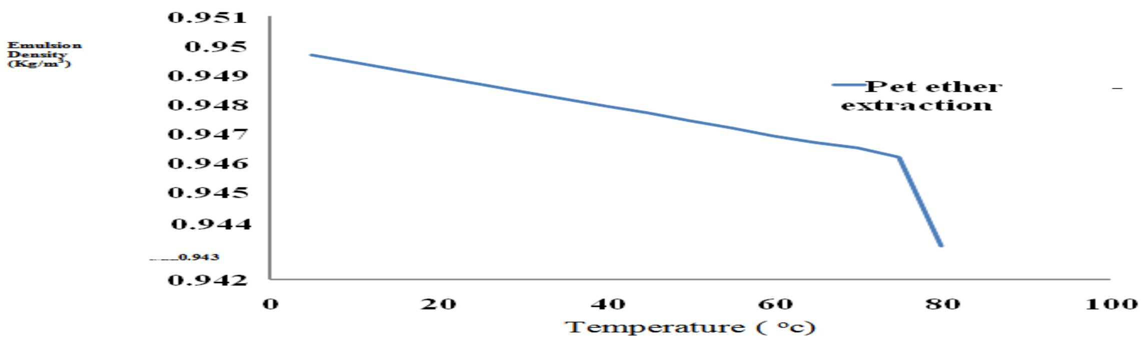

Figure 6 Density of fluted pumpkin seed oil emulsion extracted with petroleum ether at 1 bar atmospheric pressure as a function of temperature.

Density of fluted pumpkin seed oil emulsion extracted with n-hexane at 1 bar atmospheric pressure as a function of temperature

Figure 7 shows the density of fluted pumpkin seed oil emulsion extracted with n-hexane at 1 bar atmospheric pressure as a function of temperature.

The figure showed that the density of emulsion decreases as the temperature is increased.

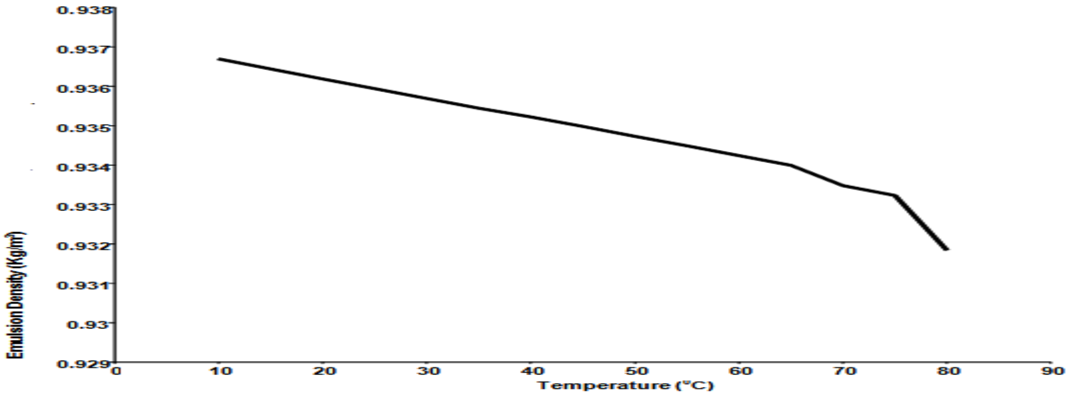

Figure 7 Density of fluted pumpkin seed oil emulsion extracted with n-hexane at 1 bar atmospheric pressure as a function of temperature.

Density of olive oil, oil extracted with n-hexane and petroleum ether emulsions at 1 bar atmospheric pressure as a function of temperature Figure 8 Shows the density of fluted pumpkin seed oil emulsion extracted petroleum ether, n-hexane and olive oil at 1 bar atmospheric pressure as a function of temperature. The figure showed that the density of emulsion decreases as the temperature is increased and showed differences in emulsion density. Also n-haxane extract and petroleum ether extract had almost the same values and which completely merged to form a single line graph.

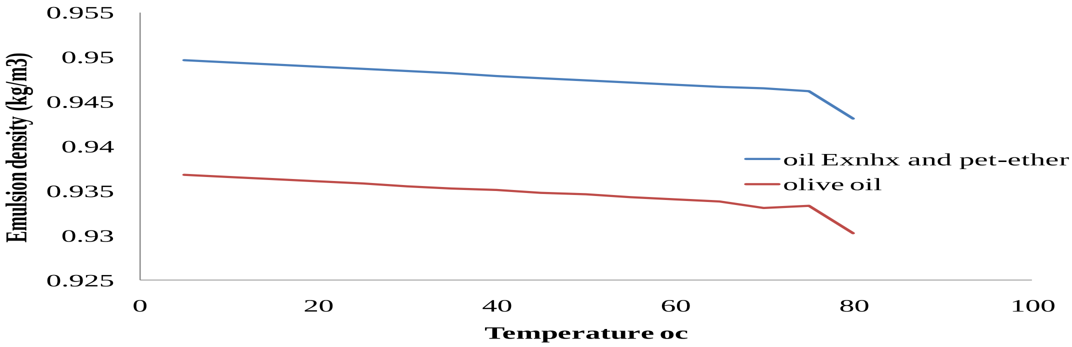

Figure 8 Density of olive oil, oil extracted with n-hexane and petroleum ether emulsions at 1 bar atmospheric pressure as a function of temperature.

Microbiological analysis: The type of organism identified as a contaminant in emulsion was E-coli.

IV. DISCUSSION

Droplet size measurement of emulsions as a function of storage time. The result illustrates that both the emulsion produced from oil extracted with n-hexane, petroleum ether and olive oil, increases at the upper level and decreases at the bottom as the emulsion ages. The spatial distributions of both emulsions droplets size change profoundly as the emulsion destabilizes. Another interesting result showed that stability test of droplet size increased proportionally on different emulsions. This can best explain the frequency of droplet collision (Robins, 2000). Since the droplet size of the emulsions increases, the probability for droplet-droplet collision resulting in coalescence also increases. This property demonstrates that storage stability test is extremely useful as they allow emulsion manufacturer to accurately follow even small changes in emulsion properties. Droplet size determination as a function of storage time can be used to determine the kinetics of the instability process and to determine the shelf life of the product by setting out to reduce droplet size to 0.1*um* to 100*um*. So, this result indicates that comparatively, the emulsion properties are quite stable and can have an extended shelf life thus promoting emulsion stability.

Result of time-dependent height increase of the visible layer (creaming or sedimentation test) is showed. This property is usually used to study the instability mechanism in emulsions. This study evaluated the effect of polyethylene glycol sorbitanmonooleate (tween 80) on the stability of fluted pumpkin seed oils extracted with n-hexane, petroleum ether and olive oil. All were oil-in-water emulsions stabilized by 20% (w/v) polyethylene glycol sorbitanmonooleate (tween 80) at 35^{o}C. Result showed that the height visible boundary layer increases as the emulsion ages, indicating that a compact cream layer was formed in the bottom of the container suggesting minimal coagulation of droplet and the delay in sedimentation indicate the onset of flocculation of the emulsion. These results are typical of emulsions that become depletion flocculated at low surfactant concentrations and stabilized at high surfactant concentrations. Depletion flocculation is the result of non-homogeneous distribution of surfactant molecule throughout the colloidal system (Chanamai and McClements, 2001).

The bulk properties of the emulsions. The initial state of the emulsion can be defined by a set of internal parameters. Some of the bulk parameters used to describe the state of an emulsion is droplet size and concentration. Since the bulk properties of emulsions such as color, texture and taste are primarily the function of these two colloidal parameters (McClements, 1999) and (Serra, and Casamitjana, (1998). parameters such as pH and microbial load can further define the initial state of the emulsions. This result also showed that emulsions produced from olive oil had the least microbial load or contamination of $6.67x10^4$ cell/ml when compared to fluted pumpkin seed oil, this suggest that olive oil is refined while oil extracted from fluted pumpkin seeds is crude. Oil extracted with petroleum ether and hexane had the same microbial contamination of $2.67x10^5$ cells/ml. This result indicate that the shelf life of olive oil emulsions is least affected by bacterial growth. And its half life can be extended. Compared to the emulsions produced from oils extracted with n-hexane and petroleum ether. However, the major organism that grows prominent in the emulsion was identified as E-coli. The implication of the presence of this organism in emulsion is that it promotes rancidity and facilitates destabilization of emulsion (Rousseau, 2000). The effect of temperature on emulsion density. This illustrate that the density of emulsion does not destabilize spontaneously at different temperature. Instead, the emulsions disintegrate gradually with response to variable temperature, to produce a curve, Israelachvili, (1992). The above figure also indicates that at 70^{o}C to 80^{o}C, the emulsions densities decreases rapidly. Suggesting that at that temperature change, the emulsion losses its integrity.

The results of apparent emulsion densities difference between the olive oil emulsions and fluted pumpkin seed oils emulsions extracted with n-hexane and petroleum ether respectively, showed that emulsions produced from fluted pumpkin seed oil was denser than emulsions produced from olive oil. Thus, a slight separation of the two curves lies parallel to each other. This result described the relationship between the density of the continuous phase, the emulsion density, and the volume which is the measure of the oil droplet concentration. An essential part of this measurement was the precise determination of density, as small temperature fluctuations can result in large errors in calculating densities of emulsion. Though temperature affects the stability of emulsions, we do not feel it was the only factor.

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