A prelude to standardize the preparation of nah poh: Effect of emulsifying agent and crude palm oil types on the stability of emulsion.

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Abstract

In Cameroon there exist a soup known as yellow achu soup or nah poh which preparation requires the production of a non-conventional emulsion using crude palm oil. Due the value attached to the soup by Cameroonians, a study was undertaken to ease the preparatory process in view of its standardisation. A survey was conducted, and data collected were exploited to study the stability of emulsions by the measurement of conductivity and apparent viscosity. The apparent viscosity of emulsion produced using kanwa was higher (103 cP) than that produced with niky (28 cP). Appropriate crude palm oils for nah poh were those with higher phospholipid contents (10.33 ± 3.96 µg/100 g and 9.72 ± 0.93 µg/100 g respectively). The stability of crude palm oil emulsion for nah poh depends on the phospholipids content, acid value, and the emulsifying agent type.

Keywords: Crude palm oil, Kanwa, Niky, Stable emulsion, Nah poh.

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Introduction

Emulsions are used as a basis for a wide variety of naturally occurring and manufactured products in factories such as food, pharmaceutical, cosmetic, agrochemicals and petrochemicals industries. By nature, they are physically unstable. They tend to separate into two distinct phases or layers over time. Emulsions instability is expressed by breaking or cracking, coagulation, flocculation and creaming. Although some pairs of liquids are immiscible, they can be forced in an emulsion with the aid of emulsifying agents. Thus, small droplets of one liquid are spread throughout the other liquid, instead of forming two separate layers with a clear boundary between them. In the various culinary processes throughout the world, there exist a diversity of food products prepared using emulsification knowledge.

In Cameroon there exists a soup known as yellow achu soup or nah poh, which preparation process is based on the production of a non-conventional emulsion. It is an emulsion of palm oil in water, stabilized by kanwa or aqueous extracts obtained from banana peelings ashes, in which a certain number of local spices are added. It originated from the western regions of Cameroon and later on spread throughout the other regions and event abroad. It is of a great value during traditional occasions, festivals, as well as birth and death celebrations. The soup is consumed with achu (pounded Colossia esculenta) in Cameroon restaurants. It is recognized for its medicinal virtues and is traditionally used to manage several illnesses. However, the culinary practices related to the preparation of this soup suffer from the lack of intergenerational knowledge transfer, due to the variability of spices used for its preparation, and also its preparatory process. The major difficulty faced is that of making a stable crude palm oil emulsion. Attempts of solutions to understand and facilitate the preparation of more stable crude palm oil emulsion have been envisaged by Ekosse and Kuagny Mouafo, but they focused their studies only on the chemical composition of kanwa and the physicochemical properties of some crude palm oils used for this effect. Analyses to evaluate the stability of crude palm oil emulsions were focused on the surface tension of emulsions produced and on visual observations. Physicochemical modifications that occur in the emulsion were no tackled. The measurement of electrical conductivity of emulsions can effectively elucidate the microstructural changes of self-assembled colloidal systems. Information concerning phase transition can therefore be obtained with the aid of the measurement electric conductivity in emulsions [1].

The aim of the present study was to evaluate the contribution of the type of crude palm oil, kanwa and niky (potash) on the stabilization process during the preparation of nah poh, in order to ease the intergenerational culinary knowledge transfer related to its preparation.

Methods and Materials

Ten different crude palm oil samples from some areas of production in Cameroon were bought in Bamenda (NW1, NW2, SW) Bafoussam (Su, Bag) and Ngaoundere (GB, BB, Ez, Baa, Gono). Among the samples bought, there were oils recommended by crude palm oil vendors for the preparation of nah poh (NW1, NW2, Bag, GB, NO) and oils not indicated (SW, Su, ES, Baa, BB) (Table 3). Emulsifying agents were bought from petit marchE in Ngaoundere (kanwa) and food market in Bamenda (niky) [2].

Methods

The scheme diagram of work done in this manuscript is presented on figure 5.

Survey: A survey was conducted in the western regions of Cameroon and in Ngaoundere (Adamawa region of Cameroon) to determine the characteristics of appropriate crude palm oil and the types of emulsifying agents, as well as the quantities to produce a precise quality of more stable palm oil emulsion in view of the preparation of nah poh. A questionnaire was conceived using Sphinx plus2 V5 software and administered to 527 women above 30 years who usually prepare nah poh and mostly those to whom the soup is part of the food habits [3-6].

A total of 15 questions were used to determine the difficulties faced in the process of preparation of crude palm oil emulsion for nah poh. The aspects involved were:

- Steps of preparation of the soup,
- Characteristics of crude palm oil used,
- Quantification of crude palm oil used,
- Types of emulsifying agents used.

Characterization of the different crude palm oils

Determination of acid, iodine, saponification values and the phospholipid contents of crude palm oils. The stability of crude palm oil emulsion depends on the nature of the oil used. For this reason, the acid, iodine and saponification values of the palm oil purchased were determined using the methods described by UIPAC. Gums (concentrated phospholipids) were extracted with the modified batch processing method and the phospholipid content was determined by the colorimetric method for the quantitative estimation of phospholipids without acid digestion [7-10].

Colour determination: Households use the colour as an indicator to determine appropriate palm oil for nah poh. To study this practice, the colours of the crude palm oils were determined by the method described by Ismail, using the L*, a* and b* scale, where L* ranges between darkness (-) and lightness (+), a* between green (a*<0) and red (a*>0), and b* between blue (b*<0) and yellow (b*>0). The images were analysed with the aid of "Image J" software which uses the Colour Transformer 2 tool. The L*, a* and b* values were recorded. This was done in triplicate on a single pre-treated sample image. The chroma which expresses the colour intensity (C) was calculated using the following formula:

$$C = \sqrt{{a^*}^2 + {b^*}^2}$$

Study of the temperature on the viscosity of palm oil emulsions: The kind of palm oil is an important factor to succeed the preparation of nah poh as indicated by households who took part to the survey. Moreover, the viscosity of an emulsion is an important parameter to guarantee its stability. It is influenced by factors like the temperature, the type of ionic specie among others [11-18].

The simulation of the effect of temperature variations, oil/ water proportions, emulsifying agent type and quantity were evaluated with the Rapid Visco Analyser (RVA). The higher, medium and smallest quantities of ingredients (crude palm oil, water, kanwa or niky) as indicated by households were used for analyses. For each experiment, crude palm oil/water ratio (29; 24 and 19% v/v) and the appropriate type and proportion of emulsifying agents (niky or kanwa) C1 (1.11 g/100 mL), C6 (1.02 g/100 mL), and C8 (0.975 g/100 mL w/v) were put in the RVA canister, mixed with the lid to homogenize oil and water, and fitted in to the apparatus. The content was automatically homogenised at 550 rpm by the machine before the effective beginning of the experiment at 160 rpm. The crude palm oil used to study the effect of temperature on the viscosity of emulsion was the recommended palm oil for nah poh: Handmade dense palm oil (DPO). The recommended (DPO) and non-recommended Light Palm Oil (LPO) were then used for the study of stability, to appreciate the effect of the different types of palm oils on the stability of emulsions. The values of density of the crude palm oils used for experiments were earlier determined with the aid of a picnometer at 30°C and were 0.95 and 0.91 for the DPO and LPO respectively [19-23].

Study of the stability of crude palm oil emulsions

The stability of crude palm oil emulsions was studied by measuring the conductivity, Total Dissolve Solids (TDS) and pH. Each of the samples analysed was prepared using the steps of figure 6, which follows those of the process used by the majority of households. The oil/water ratio and the quantity of emulsifying agents depended on each experiment [25 and 26].

The combined methods used were used to study the stability of crude palm oil emulsions. Electric conductivity, TDS and pH were recorded after every minute, for 20min using conductivity meter HANNA instruments HI 98130. The objective was to evaluate the movements of ions in emulsions. Each experiment was repeated twice and the means were used to plot the curves. The records of TDS were used to calculate the Emulsion Stability Factor (ESF) using the following formula:

$$\text{Esf} = \frac{TDS\ Solution\ of\ emulsifying\ agent - TDS\ emulsion\ at\ 0min}{TDS\ emulsion\ after\ 20\text{min} - TDS\ emulsion\ at\ 0\ min}$$

The differences of TDS value in emulsifying agent solution and that of emulsion at 0min represent the quantity of ions adsorbed at the interface of oil droplets or interacting with oil, while the difference of TDS of emulsion between 20 and 0 min is the quantity of ions release from the oil droplets interface during the destabilization process after 20 min. The more the emulsion stability factor is high, the more the palm oil emulsion is stable.

Statistical analysis

Tabulation of data recorded in the survey was done using Sphinx v5 Plus2 Lexica Edition software. The tabulation consisted to automatically determine the number of occurrences of each modality. It was also used to calculate the mean volume of crude palm oil per division. Sigma Plot version 12 and Excel 2010 were used to plot curves. While XL STAT 2007 version was employed to do the principal components analysis, in order to determine the effect of each of the factors studied on the stability of crude palm oil emulsion (ESF).

Results and Discussion

Choice criteria and quantity of appropriate crude palm oil for the preparation of stable emulsion

Choice criteria: Crude palm oil is the main ingredients of nah poh; its consumption is not a risk for health when it is not graded. However, the choice of the kind of crude palm oil must be well done to obtain a stable nah poh. Some characteristics of appropriate crude palm oil for the preparation of nah poh given by households during the survey are found in Table 4. Values in Table 4 represent the percentage of those who answered positively.

Oil that is produced using the traditional process is preferred (62.9%) for nah poh over the one that is produced by palm oil industries. The main differences between oil extraction methods used by smallholders and the process in force in oil industries are at the level of fermentation of fruits in bunches and skimming in the traditional process which is replaced by the clarification step in industries. Moreover, the industrial process avoids bruising of fruits which are then quickly sterilised after being harvested. Analyses of oils produced by the two processes revealed the presence of solid particles in handmade bulk palm oils sold in the Littoral region of Cameroon. Fermentation and absence of clarification steps may contribute to stabilise emulsions produced with hand-made crude palm oils.

According to other women interviewed in the North-west (0.9%), good palm oil for nah poh should be the one that does not tight in the mouth, should have no odour. It should not itch at the level of the throat (2.6%), but can have the taste of palm fruits. Some of the characteristics that determine appropriate palm oil for nah poh are that, it should have small white nut in the sediment part (0.3%). It must be yellow in colour when it drops on the ground, or should be oil that is produced in the month of February. The presence of stearic acid in red palm oil is characterised by small white crystals at temperatures below 22°C. Stearic acid has been shown to cause less ricks on health than palmitic acid. It lacks cholesterol-raising effect in men. Based on this, the type of oil that may be appropriate to produce more stable emulsion for nah noh is oil that produces α-form crystals when stored. The crystallisation behaviour depends on the fatty acid composition, and affects the physico-chemical properties of end products.

Some women in the North-west (3.7%) said that it ought not to be palm oil that makes foam when gently heated on fire, produced from palm nuts that are matured and have started getting rotten, or should simply be the sediment part of palm oil. The fact of allowing palm nut to get rot approves the practice of fermenting palm nut in the traditional process of oil extraction. The diversification of answers illustrates the fact that determining the characteristics of good palm oil to produce more stable emulsions for nah poh remains a difficult task. However, Kuagny Mouafo (2013) showed that good palm oil for the preparation of stable emulsion for nah poh is the hand-made palm oils, compared to oils produced by industries. He attributed the advantage offered by hand-made palm oils to the free fatty acid and solid fat content.

Appropriate quantity of crude palm oil for the preparation of nah poh: After determining the type of palm oil to be used (Table 4), the quantity of oil for one litre of nah poh was estimated per division as presented in Table 1.

The mean volumes of palm oil used for the preparation of nah poh varied according to the different divisions. The least quantity used was from Mezam division (0.14 ± 0.04L/L of soup) whereas the highest quantity was from Bamboutos division (0.28 ± 0.26 L/ L of soup). In Bamboutos division, there are women who used much palm oil, especially those living in town (Mbouda) meanwhile those living in rural area used small quantities (Balatchi, Bangang); that is why the standard deviation is too high (0.28 ± 0.26). Nevertheless, the volume used in most divisions was between 0.17L in Bansoa and 0.24L/ L of nah poh in Nde division. These results were in accordance with those of Nana Ngassam (1997) who came out with values within the range of values obtained in the present study in Nde (0.173 ± 0.012), Bamboutos (0.24 ± 0.03) and Mezam divisions (0.23 ± 0.017).

Processes commonly: used for the preparation of palm oil emulsion: The preparatory process of nah poh is not standard from a person to the other. It was found that the emulsifying agent is either dissolved in warmed crude palm oil or in warmed water. The main process was the one during which palm oil is warmed, then heated solution of kanwa or niky is added, stirred together to produce emulsion (40.2%). Some women made the precision that after warming and allowing the oil to get cold, kanwa or niky is added and mixed for some time before adding water.

After adding water, the entire mixture is stirred again. Sodium chloride was recommended to be put at the end when the emulsion is stable and not at the beginning. In fact, monovalent ions, especially sodium chloride favour emulsion flocculation, which leads to its destabilization. Introducing sodium chloride at the end of the preparatory process of nah poh may be recommended due to the fact that NaCl causes osmotic gradient between the content of oil droplets and the water phase out of the oil droplets, resulting to its breakdown. This shows the destabilisation effect of sodium chloride in emulsions.

It was recommended by women that spice should also be put at the end when preparing nah poh to avoid similar destabilization. The spices should not be used in the form of powder, but in the form of paste prepared with solution of niky or kanwa to avoid destabilisation.

Effect of emulsifying agent type and oil/water ratio on the viscosity of crude palm oil emulsion with respect to temperature

Case of kanwa: In this part of the work, emulsions were prepared as described in paragraph 2.3. Heating and cooling treatments were studied, to simulate the behaviour of palm oil emulsion's viscosity during the culinary processes, as practiced by women during the preparation of nah poh. The aim of this manipulation was to determine a working temperature.

Figures 1a and 1b present the simulations of the effect of cooling on the viscosity of crude palm oil emulsion, as well as the effect of the type of emulsifying agent and proportions of ingredients. The trends of the curves at the beginning of each graph (0 to 15s) represent the homogenisation phase during which the mixture was mixed at high speed (500 rpm) before the beginning of the study. After the homogenization phase, the speed was kept constant (160 rpm) throughout the study period. The temperature was set to decrease from 40 to 22°C for the cooling experiments and from 22 to 40°C for the heating experiments (Figure 1a and 1b respectively). The duration depended on the time used by the Rapid Visco Analyser to attend the required temperature. The curvatures observed in the homogenization phases express the rapid change of homogenization speed: from 0 to 500 and from 500 to 160 rpm.

List of figures

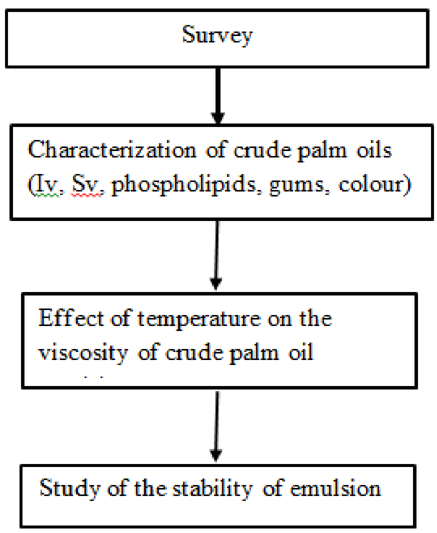


Figure 1: *Scheme diagram of work.*

Figure 1a shows that the culinary process for nah poh involving cooling presents a parabolic trend and the variation of the concentration of burned kanwa and oil water ratio has no or very slight effect on the viscosity of the palm oil emulsion. After the homogenisation phase, the viscosity of palm oil emulsion decreased with the drop of temperature, from 139 cP to 70 cP at a temperature 33.5°C. The curvature was obtained at 33.55°C and the curve then rose up to 103cP at a temperature of 25.8°C. The palm oil emulsion prepared with the smallest ratio of crude palm oil/water ratio (19%) had the highest viscosity throughout the experiment (green coloured curve). The value of the temperature can easily be obtained by a projection on the bleu curve, then on the secondary vertical axis.

The process involving heating presents a hyperbolic trend (1b). The oil proportion has an increasing effect on the viscosity of crude palm oil emulsion, compared to the cooling process. From 230cP at 25.55°C, the highest viscosity 279cP was recorded at 28.25°C and decreased to 121cP at the temperature of 39.85°C. The decrease of viscosity was continuous, and could be due to emulsion destabilisation during which palm oil tends to separate from water as a result of bonds braking between oil droplets and emulsifying agents. Allouche (2003) reported that the change of viscosity of emulsions expresses the phase inverse temperature (PIT), during which there is formation of multiple structures like W/O/W emulsions. He reported two phase inversion temperatures in his study during cooling. The first was at 33°C and the second at 27°C.

Case of niky: A similar experiment using niky was carried out in the same conditions, and results are presented in figures 2a and 2b.

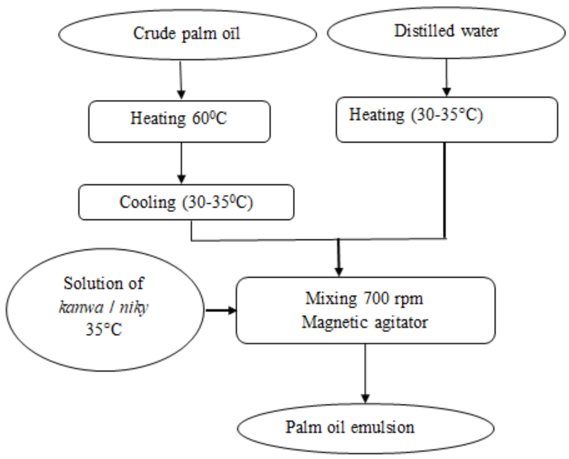


Figure2: *Process used for the preparation of crude palm oil emulsions.*

The same experiments repeated using niky showed very slight viscosity variations, no matter the oil/water ratio or the quantity of emulsifying agent.

This may be due to the difference in the composition of the emulsifying agents. Ekosse reported that kanwa is essentially made up of sodium carbonate while niky results from incineration of banana peels. Based on the mineral composition of banana ashes, niky may essentially be made up of metal oxides like K_2O, Na_2O, MgO, CaO, CuO, FeO, ZnO. The maximum viscosity was 28cP at 39.7°C while the minimum value was 21cP at 25°C. After the homogenisation phase, the curves do not present any curvature. Nah poh prepared using niky is less viscous than the one produced using kanwa. The viscosity however diminishes slightly with the rise of temperature. The maximum viscosity for the heating process was 29 cP at 25.15 °C while the minimum was 16cP at 39.9°C (2a).

Effect of emulsifying agent type on the conductivity and pH of palm oil emulsions

Two types of oils were used to study the effect of the type of crude palm oil on the stability of emulsions. The two types of oils included low density crude palm oil 0.91 (LPO) non-recommended for the soup and dense (0.95) red palm oil (DPO) which is recommended by households.

Case of light crude palm oil (LPO): Emulsions were prepared and the recorded values of conductivity were used to plot the curves presented by figure 3a.

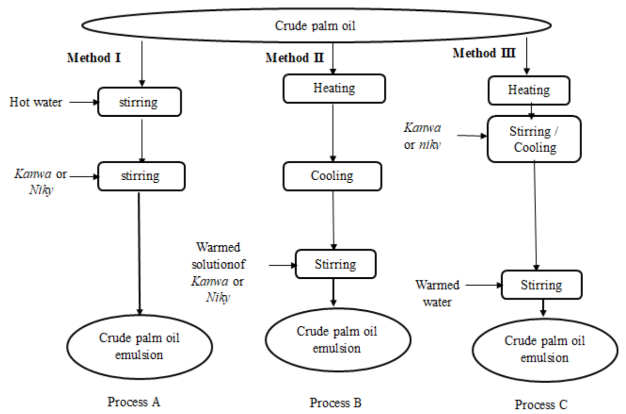


Figure 3: *Processes of production of crude palm oil emulsion in view of preparation of nah poh.*

This result shows that the variation of conductivity was very high with emulsions prepared using LPO and niky. The initial conductivity value was 8.03 ± 0.32 mS/cm and at the 20th min it rose up to 12.72 ± 0.25 mS/cm. The variation of electric conductivity values in emulsions prepared using niky reveals the instability of such emulsions. However, it was noted that emulsions prepared using burned kanwa had very high values of conductivity which were almost stable throughout the experiment. The low variation of conductivity may be explained by the fact that many ions remain adsorbed at the surface of oil droplets. The slower are the properties of emulsion changes, the more stable is the emulsion. The instability of emulsions prepared using niky may be due to a diversity of ions species as it results from incineration of banana peels. According to McClements depletion flocculation occurs if there is too much polyelectrolytes present in the continuous phase.The values of pH recorded simultaneously with the conductivity are presented on figure 8.

The pH of emulsions prepared with niky and burned kanwa were higher than that of emulsions prepared with non-burned kanwa. From the curves on figure 8, it was noted that the pH generally decreased slightly. The variation of the pH when the non-burned kanwa was used was 0.03 ± 0.01, that of emulsions prepared with burned kanwa was 0.11 ± 0.01 and the variation of the pH of emulsions prepared using niky was 0.10 ± 0.03. equally reported the decrease of pH with time, during destabilisation of emulsion. The pH variations in an emulsion results from modifications taking place in the emulsion. Due to the basic nature of the medium, the decrease of pH can be attributed to hydrolysis of triglycerides.

Case of dense crude palm oil (DPO): Figure3b shows the conductivity variation of emulsions prepared with DPO and 3 different emulsifying agents with respect to time.

The variation of conductivity in DPO emulsion was generally not high compared to LPO emulsion. From figure 3b, after stirring, the initial conductivity of the emulsion using the non-burned kanwa was 2.15 ± 0.84 mS/cm and at the 20th min it was 2.81 ± 0.55 mS/cm. The initial conductivity of the emulsion using burned kanwa was 4.21 ± 0.54 mS/cm and at the 20th min it was 4.84 ± 0.12 mS/cm. As for emulsion prepared with niky, the initial conductivity was 1.87 ± 0.15 mS and at the 20th min was 2.79 ± 0.78 mS. The variation of conductivity in emulsions prepared using burned kanwa was less compared to emulsion prepared using non-burned kanwa and niky. This may be explained by the low mobility of ions from the interface of the oil droplets to the aqueous medium in emulsion prepared with burned kanwa. The mobility of ions in emulsions prepared using non-burned kanwa and niky was more important with time. The values of pH recorded simultaneously are presented on figure 9.

The pH of emulsion prepared using burned kanwa was highest, followed by that of non-burned kanwa and niky respectively. From figure 9, it was noticed that the trends of pH for all the three emulsifying agent types prepared with the DPO were almost similar. Emulsion prepared with non-burned kanwa had the highest variation of pH (0.27 ± 0.06) Comparing figures 8 and 9, it can be deduced that there was more stability for emulsions prepared using DPO than LPO. There was a general decrease of pH in emulsions prepared with both palm oils. The decrease of pH may be due to hydrolysis of esterified fatty acid into free fatty acid and other products.

Effect of some physico-chemical properties of crude palm oil on the stability of emulsion

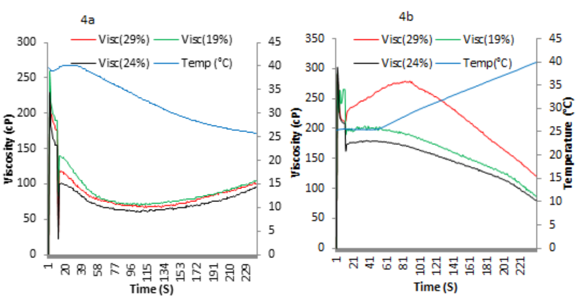
During the survey, participants gave answers which indicated that the physico-chemical properties of crude palm oil used for the preparation of nah poh have effects on the stability of the resulting emulsion. For this reason, the colour, iodine, acid, saponification values and phospholipids content of crude palm oils were evaluated and results are presented in Table 2.

Crude palm oil samples having high gum content equally had high phospholipid content. All the same, those with high phospholipid contents equally had high emulsion stability factor values (BB and NW1). There was a correlation between the phospholipid contents of crude palm oil and the stability of the resulting emulsion. The oil samples with low chroma (C) or colour intensity and b* values had higher values of ESF (BB and NW1). There may also be a correlation between these two palm oil colour parameters and the stability of emulsions while the relation between the acid, iodine, and saponification values cannot be easily deduced.

Citation: *Stève Djiazet, Laurette Blandine Mezajoug Kenfack, Clergé Tchiégang. A prelude to standardize the preparation of nah poh: Effect of emulsifying agent and crude palm oil types on the stability of emulsion. J Food Sci Nutr 2021;4(10):1-11.*

In order to contribute to the understanding of most plausible factors contributing to the stability of crude palm oil emulsion in view of the preparation of nah poh, the correlation cercle for the different parameters (figure 4a) and the Principal Component Analysis (PCA) (figure 4b) were done. In the methodology that uses the PCA to study scientific phenomena, well represented variables are those that are nearer to the correlation circle. Well represented variables are positively correlated if they are closed each to the other. They are not correlated if they are opposed to each other. There is no correlation between variables if the vectors representing them have orthogonal directions. In the present study, a PCA was performed to visualize the correlations that exist between the different variables studied.

It can be seen on figure 4b that nearly all the variables are well represented with respect to the ESF. There was a correlation between the acid values of the crude palm oils and the phospholipid contents. All the same, there was a correlation between the iodine and saponification values of the oils and the emulsion stability factor. However, the correlation between some parameters of the oils colour like the chroma (C), L* and the ESF was not well represented. The correlation between the acid value and phospholipids is higher than that with the gum content. Figure 4b presents the PCA plotted using the colour indicators (Lab values), iodine value, saponification value, acid value and the phospholipid content of the crude palm oils with respect to the different crude palm oils.



Figures 4: *Effect of cooling (4a), heating (4b) and the concentration of kanwa on the viscosity of crude palm oil emulsion.*

From figure 4b, it can be deduced that crude palm oils like NW1, NO, Bag are correlated to the ESF. In fact, NW1, NO and BB had the higher values of ESF which were 26.29, 18.79 and 17.03 respectively. Emulsions that presented the low values of ESF were apparently unstable.

This instability was materialized by creaming at the surface of the emulsions produced. It can also be visualized from the same figure that the crude palm oils with high ESF were of yellow colour (high positive values of b*). The presence of Baa among NW1 and NO may be due to the fact that they had almost the same iodine value. The oil sample from Bafia (Baa) was of bright red colour and the a* value was high (49.48 ± 0.56).

There was a correlation between the phospholipid contents of the crude palm oils and the ESF. This means that the darkened colour (high values of C*) of crude palm oils may be due to the phospholipid contents and could contribute to produce more stable crude palm oil emulsions. The oil sample with the highest phospholipid content was NW1, with 10.33 ± 3.96 µg/100 g and the oil sample with the least phospholipid content was Baa, with 4.56 ± 0.57 µg/100 g.

Generally, the acid values of the different oil samples were out of the recommended range. The high acid values of the different oils may be explained by the fact that they were not refined. The acid value of BB was too high (77.2), compared to those of NW1 and NO which were 26.6 and 26.27 respectively.

This may justify its position on figure 4b, and may be explained by the phospholipids content of crude palm oils that acts in favourable conditions like a pro-oxidant in crude palm oils and as a tension-active substance in emulsions. Thang and Zairey showed that palm fibres are source of lecithin. The process used by traditional processors may favour extraction of lecithin from fibres in to palm oil, and the process may not enable the elimination of the phospholipids from resulting crude oils, compared to the industrial process.

Table 1: *List of purchased samples used to produce crude palm oil emulsion and their origins.*

Samples	**Origin**
kanwa	Ngaoundere
niky	Bamenda
Crude palm oil NW1	Bamenda
Crude palm oil NW2	Bamenda
Crude palm oil Bafang	Bafoussam
Crude palm oil Bafang BB	Bafoussam
Crude palm oil Bafia	Nagoundere

Crude palm oil CDC	Bamenda
Crude palm oil Eseka	Ngaoundere
Crude palm oil Souza	Ngaoundere
Crude palm Bafang bad	Bafoussam
Crude palm oil Unknown origin	Ngaoundere
CDC: Cameroon Development Corporation, NW: North-West region of Cameroon	

Table 2: *Characteristics of good palm oil for nah poh in % of interviewees.*

	Regions				
for nah poh	Nw	Sw	W	Ndere	Total
No response	20.2	26	34.4	0	30
Any oil	0	0	0.3	0	0.2
Does not have bade odour	4.6	0	1	0	1.8
Floating part of oil	0	0	0.3	0	0.2
Does not tight in the mouth	0	2.6	0	0	0.2
Has the taste of palm nut	0	0	0.3	0	0.2
Industrial production from CDC	0.9	0	0.8	0	0.8
Contains white small nut	0	0	0.3	0	0.2
Does not quickly make foam in water	0	2.6	0	0	0.2
Yellow in colour when it drops on the ground	0	0	0.3	0	0.2
Should have no taste	0	2.6	0	0	0.2
Traditional production (Handmade)	65.1	72	61.3	0	62.9
Makes the soup to quickly get thick	0	0	0.3	0	0.2
Yellow in colour	0.9	0	0.5	0.2	0.6
Oil produce in February is the best	0	0	0.3	0	0.2
Oil that does not itch at the throat	0.9	0	0	0	0.2
Produced from palm nut that has started getting rotten	1.8	0	0	0	0.4
Do not make foam on fire	3.7	0	0	1.2	0.8
Oil foot sediment	3.7	0	2.7	1.2	2.7
Tick	0	0	0	1.2	0.4
Moderately red	0	0	0	1.2	0.4
Ndere: Ngaounere; NW: North-west; SW: South-west; W: West; CDC: Cameroon Development Corporation, Number of participants: 517					

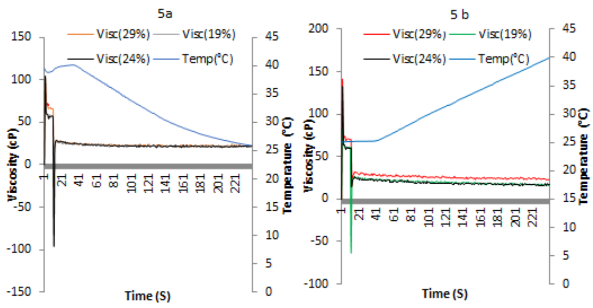
Citation: *Stève Djiazet, Laurette Blandine Mezajoug Kenfack, Clergé Tchiégang. A prelude to standardize the preparation of nah poh: Effect of emulsifying agent and crude palm oil types on the stability of emulsion. J Food Sci Nutr 2021;4(10):1-11.*

Table 3: *Volume of palm oil (L) for 1L of nah poh.*

Divisions	Volume (L) of palm oil for 1L nah poh
Upper Nkam (UN)	0.24 ± 0.03
Mifi (Mi)	0.23 ± 0.09
Upper Plateau (UP)	0.22 ± 0.09
Mezam (Mez)	0.14 ± 0.04
Koung- Khi (KKi)	0.21 ± 0.06
Nde (N)	0.24 ± 0.07
Bafang (Ba)	0.17 ± 0.08
Menoua (Me)	0.23 ± 0.09
Lebialem (Le)	0.20 ± 0.06
Bamboutos (Bam)	0.28 ± 0.26
Ngaoundere (Nga)	0.27 ± 0.09

Table 4: *Effect of gum, phospholipids contents; colour parameter, acid, iodine and saponification values of crude palm oils on the stability of emulsions.*

Samples	Gum	Phospholipids	ESF	AV	SV	IV	L*	a*	b*	C
	g/100g palm oil	µg/100g palm oil								
BB	1.37 ± 0.17c	9.72 ± 0.93d	17.03 ± 0.057e	87.40 ± 0.80f	79.27 ± 5.11bc	86.17 ± 17bc	40.90 ± 3.99ab	31.46 ± 1.80a	28.32 ± 1.74a	42.33 ± 2.49a
Bag	0.98 ± 0.25c	7.31 ± 2.66bcd	5.55 ± 1.48ab	38.56 ± 0.12e	72.15 ± 3.95ef	101.98 ± 1.45ef	58.37 ± 1.68b	36.28 ± 0.23b	56.52 ± 1.35ef	67.18 ± 1.38c
Baa	0.74 ± 0.15ab	4.50 ± 0.57a	4.43 ± 1.69ab	24.91 ± 0.75a	74.89 ± 3.95h	118.89 ± 7.60h	56.19 ± 3.83b	49.48 ± 0.56g	58.22 ± 2.25f	76.4 ± 2.33g
ES	0.83 ± 0.15bc	5.52 ± 0.42a	8.47 ± 0.44cd	23.65 ± 6.50a	76.38 ± 5.96b	79.57 ± 5.65b	58.47 ± 2.04b	45.62 ± 0.76de	54.63 ± 0.53e	71.17 ± 0.93f
NO	1.36 ± 0.15c	7.21 ± 1.41abc	18.79 ± 0.93e	26.27 ± 1.88b	82.52 ± 4.31gh	113.83 ± 3.33gh	58.33 ± 0.72b	43.45 ± 0.04cd	54.25 ± 0.30e	69.5 ± 0.93de
GB	0.83 ± 0.10ab	6.59 ± 1.16ab	3.23 ± 0.25a	38.13 ± 1.50de	71.19 ± 3.74de	98.97 ± 3.28de	51.07 ± 2.97ab	43.69 ± 0.82cd	44.94 ± 0.21b	62.68 ± 0.84b
NW1	1.46 ± 0.14c	10.33 ± 3.96d	26.29 ± 1.16f	37.2 ± 0.73d	70.13 ± 1.24a	70.13 ± 1.24a	52.60 ± 1.01ab	41.68 ± 0.59c	48.30 ± 0.64c	63.8 ± 0.87b
NW2	0.64 ± 0.14c	5.64 ± 0.37a	11.12 ± 0.93d	38.5 ± 0.53de	93.15 ± 3.06cde	93.15 ± 3.06cde	55.91 ± 1.57b	45.76 ± 0.63de	51.12 ± 1.52d	68.61 ± 1.64d
SU	0.75 ± 0.15ab	5.02 ± 34a	3.26 ± 0.80a	26.60 ± 0.11b	92.80 ± 8.93cd	92.80 ± 8.93cd	53.64 ± 3.37b	46.63 ± 0.14e	55.69 ± 1.69e	72.64 ± 1.69f
SW	0.51 ± 0.18a	9.49 ± 1.90cd	6.63 ± 0.93bc	31.78 ± 0.18c	109.21 ± 6.76fg	109.21 ± 2.81fg	56.13 ± 2.50a	50.49 ± 0.16f	51.54 ± 1.39d	72.14 ± 1.40f



Figures 5: *Effect of cooling (5a), heating (5b) and the concentration of niky on the viscosity of crude palm oil emulsion.*

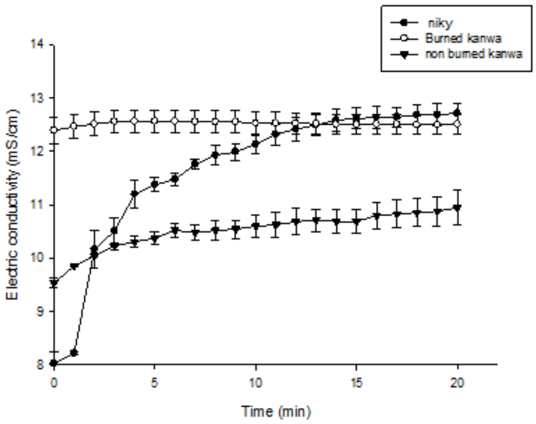


Figure 6: *Conductivity values in mS/cm of LPO emulsion. prepared with different emulsifying agents with respect to time.*

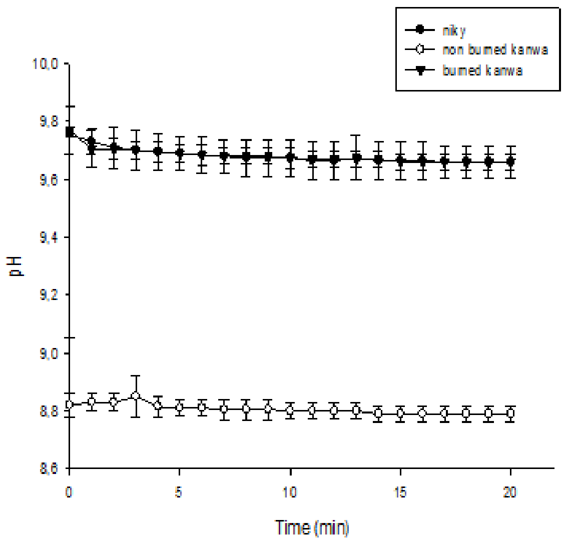


Figure 7: *pH of palm oil emulsions prepared with LPO and different emulsifying agents with respect to time.*

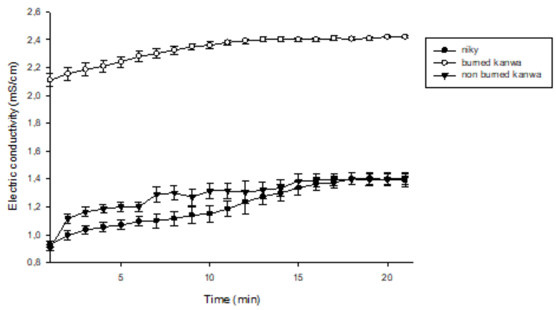


Figure 8: *Conductivity values of DPO emulsions prepared with different emulsifying agents with respect to time.*

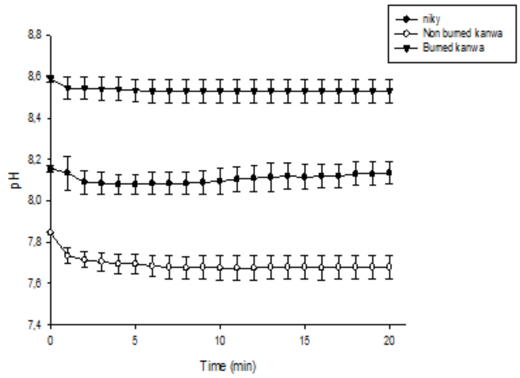


Figure 9: *pH of palm oil emulsions prepared with DPO and different emulsifying agents with respect to time.*

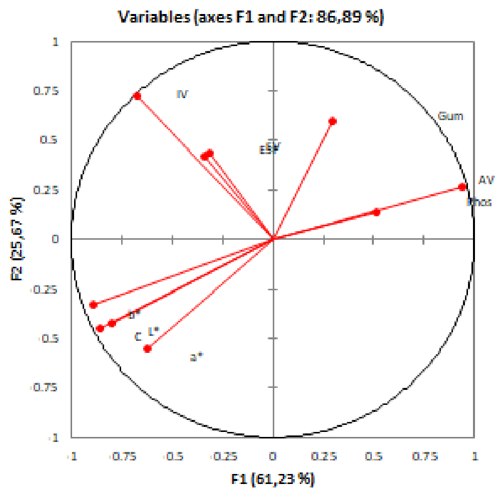


Figure 10: *Presenting acid value (AV), iodine value (IV), saponification value (SV), emulsion stability factor (ESF) of crude palm oil.*

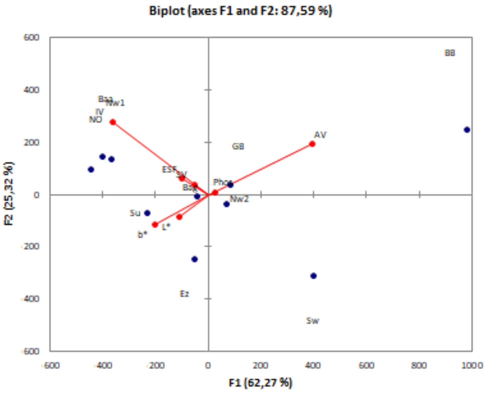


Figure 11: *PCA of the effect of crude palm oil types with respect to the indicators of oil characterization, NW1: North west1, NO: palm oil from unknown origin, Bag: Bafang, NW2: North west2, Baa: Bafia, GB: good Bafang, BB: bad Bafang, SW: South west, EZ: Eseka, Su: Souza, AV: acid value, IV: iodine value, SV: saponification value, ESF: emulsion stability factor.*

Conclusion

The present study demonstrated that there are three main processes often used by households for the production of palm oil emulsions in view of preparation of nah poh. The apparent viscosity of palm oil emulsion prepared using kanwa varies with respect to temperature and is higher than that prepared using niky which does not vary much with temperature. Low density crude palm oils produce less stable emulsions than the high density crude palm oils. The phospholipid content of crude palm oils sold in some local markets varies from an oil sample to the other and depends on the process of extraction used. Crude palm oils with high phospholipid content values contribute to have more stable emulsion in view of the preparation of nah poh [24].

Conflict of Interest

The authors declare no conflict of interest.

Consent to Participate

During the survey part of the present work, some households were questioned, and each of them freely agreed to take part to the study.

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