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The Characterization of Tri-Ethanolamine Soap Produced from the Fatty Glycerol of Chicken Skin as a Water/Oil Emulsifier

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ABSTRACT

The main lipid extracted from chicken skin at high temperature was used as an initial material for producing a specific emulsifier for a water/oil dispersion system. More than 30 different compounds including saturated, mono-unsaturated and multi unsaturated fatty acids were identified through GC-MS analysis of the methylated ester of the extracted fatty glycerol. The transformation of soap to fatty acid was performed using hydrochloric acid with a 1:1 mole ratio. The collected fatty acids were reacted with triethanol amine in a refluxed system over 90ºC for 1 hour. The application of triethanolamine soap as an emulsifier for dispersing of water droplet in oil phase (W/O) was confirmed. The surface tension, stability of emulsion in alcohol and electrolyte for a long period of time studied. The dynamic viscosity was determined, and the results showed that higher concentration of emulsifier in water volume fraction lower than 25% were effective in stabilizing the W/O emulsion at room temperature.

Keywords: chicken skin, fatty glycerol, tri-ethanolamine, soap, emulsifier.

Introduction

Today, chicken is one of the most consumed protein sources in the world. In food produced from animals, the use of hormonal and also antibacterial growth promoters has raised many concerns regarding their impact on human health. In Iran, commercially, the most available chickens are injected with hormones and antibiotics rending them highly unnatural. The required chemicals consumed by the chicken are stored in the fat," says Rucker. "Since the skin contains mostly fat, therefore this part of the bird can be highly toxic when eaten.[1,2] Lipid from whole chicken skin produces the greatest diffusion feedback, followed by free fatty acids and free sterol skin fractions. In this respect, considerable quantities of unused chicken by-products such as organs and skin can be retrieved from daily chicken consumption. These products are mostly used as feeds or cheap fertilizers.[3] The inter esterification of chicken skin fat and branched-chain fatty acids lipase-catalyzed reaction is carried out at different conditions to modify the lipids rich in polyunsaturated fatty acids. It is possible to design the formation of various lipid structures in order to obtain desired properties and nutritional values.[4]

The potential for further added-value via application of unused chicken waste products has been investigated in several research works. The extraction of collagen from chicken skin has also been studied using various techniques.[5,6] Recently this procedure was carried out using three different organic acids and pepsin in low temperature to protect nutritional values of fat and denature the protein. The highest collagen yield (~3.68%), purity (~72.19%) and recovery (~78.26%) has been reported by Lin CW.[7]

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Biodiesel refers to a vegetable oil /animal fat-based diesel fuel subtending of long chain alkyl (methyl, ethyl, or propyl) esters. Biodiesel (fatty acid ester) can be produced by the chemical reaction between lipids (vegetable oil, soybean oil, animal fat) and alcohol. It has been determined that pure fatty acid methyl esters of animal origin do not meet standard requirements and cannot be used directly in diesel engines. The combination of seed oil methyl ester and animal fatty methyl esters may be used as a fuel.[8] Supercritical trans-esterification of chicken fatty glycerol as a biodiesel at high pressure and temperature has also been investigated.[9] The production of methyl, ethyl ester of the extracted lipid from chicken waste and their fuel characteristics has also been studied.[10]

Moreover, the extraction of complex lipids including shingolipid and plasmalogen from chicken skin has been reported.[11,12] They have found that the total lipid yield from chicken skin (32g/100g) contained 2% complex lipid. The highly purified shingomyelin (95 wt%) was prepared by a combination of solvent fractionation and alkaline/acidic hydrolysis from the ethanol extract. The authors have claimed that this type of lipid can be a potential resource for antioxidant phospholipid plasmalogens and human-type sphingolipid.

The identification of fatty acid in chicken skin has been reviewed in several articles. The first analysis was carried out using a combination of quantitative thin-layer and gas-liquid chromatography and by chemical and spectroscopic methods. The lipid groups identified: wax diesters (34%), triglycerides (32%), sterols (ll%), phospholipids (11%), nonphosphorus-containing sphingolipids (3%), β -D-ghcosylsterols (3%), 6-O-acyl-β-D-glucosylsterols (2%), steryl esters (l%),cholesteryl sulfate (1%)and free fatty acids (1%).[13] The fatty acid profile of chicken skin fat showed 43% oleic acid, 27% palmitic and 14% linoleic acid. In comparison to the other source of animal fat, chicken has the highest amount of unsaturated fatty acids (65-68%).[14-16] In the extracted oil from the chicken skin, the type of fatty acid has been reported in several researches to contain: 42.5% (C18:1), 27.1% (C16:0), 14.1% (C18:2), 8% (C16:1) and also 6.3% (C18:0).[17]

The analysis of fatty acids and cholesterol content of chicken skin has been studied using GC-MS and enzymatic method respectively.[18] The presence of 8 saturated and 3 monounsaturated fatty acids has been indicated. The skin's cholesterol content was 131 mg/100g which is still very high in comparison with the other bird's meat. The different classes of saturated fatty acids have been reported to have different effects on

plasma lipid and lipoprotein levels.[19] Long chain saturated fatty acids (12:0 – 18:0) have been associated with an increase in cardiovascular disease. Therefore, it has been recommended to remove the skin of poultry with the intent of reducing fat intake.

Surfactants are surface active agents, molecules that have a significant role in emulsions, suspensions and foams. They find comprehensive application in personal care, cosmetics, pharmaceuticals, and agrochemicals and food industry. In the surfactant industry, oleochemical hydrophobic building blocks are based on natural oils and fats play an important role on producing new material with specific properties. The most important factors with regards to raw material choice are availability, composition and cost effectiveness. The extracted fatty acids from chicken skin can be used as a major source for the hydrophobic part of surfactants. The physicochemical behavior of a surfactant in water and its applications are determined by the balance between the lyophilic and lyophobic portions of the molecule. The lyophobic section may be branched or linear, and the length of the chain is in the range of 8-18 carbon atoms[20]. In accordance with this information it can be easily claimed that the extracted specific fatty acid from chicken skin is an ideal source for supplying various types of surfactants with different properties for different applications. In this research work, the synthesis of surfactants from chicken skin lipid has been investigated. The identification and determination of the fatty acid extracted from chicken skin has been reported using GS-Mass technique. The production of soap with specific application as an emulsifier of dispersion of water droplets in oil (W/O) with desirable stability has also been indicated.

Materials and Methods
Materials
The fresh chicken skin as a waste material provided from the local shops, composed of chicken skin, fat and a few other tissues. The minced chicken wastes were frozen, stored and then thawed at room temperature just before use. 100 g weighted chicken waste were placed in a container and heated at 80°C for one hour to be molten. Freshly extracted oil (~34g) was directly used through the experiments.
Preparation of products

Soap
100 g extracted fatty glycerol, 33g of sodium hydroxide and 50cc of water were reacted at boil temperature until the floating soap was produced. The purification of soap was done by collecting and dissolving the soap in the boiled water and purifying it using sodium chloride for several times.

Trans esterification
The fatty acid methyl ester was produced from trans estrification by reaction of the chicken skin fatty glycerol with alcohol. 40 g extracted chicken oil at uniform temperature 50°C was reacted with 8.0 g methanol and 0.4 g potassium hydroxide was used as a catalyst. The prepared solution was stirred for 2 hours at boiling temperature in the reflux condenser system. The produced methyl esters were separated from the rest of glycerol, using a separating funnel, and washed with hot water (70°C) to remove any residual alcohol and catalyst from them. The gas chromatography analysis was performed on chicken skin methylated fatty acid to identify the fatty acid composition.

The preparation of fatty acids
The acid hydrolysis of the prepared soap was performed, and the glycerin was removed. The soap powder (40 g) was treated with 120 mL concentrated HCl at room temperature while a mechanical stirrer was used in this operation. 35 mL of dimethyl ether was added to the hydrolysis solution to separate fatty acids. In the separating funnel, the dissolved fatty acid in ether was removed. After several times of purification, the FT-IR spectrum of the samples was obtained.

The preparation of soap
The collected fatty acids set containing various types of long chain hydrocarbons were reacted with 8.47 g of fatty acid and 1.49 g of tri-ethanolamine along with several drops of concentrated sulfuric acid which were introduced into a 250 mL three-necked flask equipped with a stirrer, internal thermometer and distillation bridge. The reaction mixture was then heated to a temperature of 250°C for 2 hours. The

products were treated with 20 ml of dimethyl ether and washed with distillated water. The separation of organic and inorganic phases was performed using a separator funnel. In the next step the organic phase (upper phase) was reacted with a 10% sodium bicarbonate solution to collect the final products. The soap formation has been confirmed in FT-IR spectrum of the products.

Characterization of samples
Fourier-transform infra-red spectroscopy (FT-IR): The chemical structure of extracted fatty glycerol, primary soap, and tri-ethanolamine soap was studied using Perkin-Elmer 1740 FT-IR spectrophotometer with diamond ATR attachment.

GC-MS: The analysis of methylated fatty acids extracted from chicken skin was performed using Agilent 5975C series GC/MSD.

Turbidity measurement
Turbidity of the surfactant solution was determined using Photometer 8000, from the Palintest Company in the UK.

Electrical Conductivity
The electrical conductivity of surfactant solution was measured using Conductivity TDS Meter Model 4510.

The type of emulsifier
The emulsion type was identified by observing what happened when a drop of each emulsion was added to a volume of either pure paraffin or pure water. In the W/O emulsion, the drops were dispersed in oil and remained as a drop in water, while in O/W emulsion the drops were dispersed in water and remained as a drop in oil. The tri-ethanolamine soap provided from chicken lipids was found as a W/O emulsifier.

The stability of emulsion
The stability of the provided emulsions with the new emulsifier against sedimentation and coalescence was assessed altogether by the total separated volume of water plus paraffin divided by the total sample volume from the eq. (1):

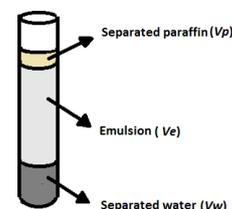$$\text{Separation (\%)} = \frac{(Vs)}{(V)} = \frac{Vw+Vp}{Vw+Vp+Ve} \quad (1)$$

Where:
Vs: Separated volume of water plus paraffin,
Vw: Volume of separated water,
Vp: Volume of separated paraffin,
Ve: Volume of emulsion,

The effect of several parameters on stability of the emulsion was studied after 30 days, including, the surfactant, alcohol and salt content, the ratio of water and oil in the emulsion and also the mixing conditions (time and velocity).

Surface tension measurement
The surface tension of the products was measured by comparing liquid drops' volumes, both liquids dripping from the same burette. In this experiment, distilled water was used as a liquid with known surface tension. The surface tension of the 1% solution of the synthesized surfactant in water was determined from eq. (2):

$$\gamma_2 = \gamma_1 \frac{v_2 \cdot \rho_2}{v_1 \cdot \rho_1} \qquad (2)$$

Where γ_1 is surface tension of distilled water, v_2 is the volume of 100 drops of surfactant solution, v_1 is the volume of 100 drops of water, ρ_1 the density of water and ρ_2 the density of surfactant solution.

Manifestations of micelle formation (CMC)
In the study of the solution of surface active agents, it became clear that the bulk solution properties of such materials were unusual and could change dramatically over very small concentration ranges. The measurement of bulk solution properties such as surface tension, electrical conductivity or light scattering as a function of surfactant concentration produce curves that exhibit relatively sharp discontinuities at comparatively low concentration. In these measured

properties, the sudden change is interpreted as a significant change in the nature of the solute species. In fact above this surfactant concentration, micelles form and all the additional surfactant added to the system go to micelles representing critical micelle concentration (CMC). In this study, the electrical conductivity and light scattering parameters were measured for various concentrations of an emulsifier.

The size of water droplets in an emulsion

The sizes of water drops were determined using an optical microscope, Projectina Microscope from Shirly Company facilities, with camera and image analysis software Image Pro Plus 4.0 from Media Cybernetics. Samples were prepared by placing a drop of an emulsion on the microscope slide with a fine needle, spreading it in order to produce a thin layer, such that light can pass through it. The transmitted light was used for studying the samples with eye-pieces magnification of 10X and 40X.

Results and Discussion

FT-IR

Fatty glycerol: The FT-IR of fatty glycerol extracted from the chicken skin is shown in Figure 1. In this spectrum the bands at 2923 cm^{-1} and 2863cm^{-1} are assigned for asymmetric and symmetric stretching vibration of CH$_2$ group. The C=O stretching vibration of the ester group in fatty glycerol appears at 1742cm^{-1}. The C-H scissoring and bending vibration of methylenol group is identified at 1462 cm^{-1}, while the asymmetric vibration of –CH$_3$ is seen at 1437cm^{-1}. The bending vibration of glycerol group O-CH$_2$ (mono-di and triglycerides) is attributed to 1377cm^{-1}, however in this complex fatty glycerol moved to the low frequency of 1361cm^{-1}.

Soap: The FT-IR spectrum of fatty glycerol that has been reacted with sodium hydroxide to produce soap is shown in Figure 2. The stretching vibration of the carbonyl group of fatty glycerol (ester linkage) has been removed in this spectrum, confirming the formation of soap. The ester group of soap appears at 1558cm^{-1}.

Fatty acids: The FT-IR spectrum of fatty acids extracted from the chicken skin is also provided in Figure 3. It is clear that the carbonyl functional group of acid is represented at 1706 cm^{-1}. The specific band relevant to the fatty glycerol, O-CH$_2$, in mono, di and triglycerides at 1377 cm^{-1} has disappeared in the fatty acid spectrum. The two strong bands in the specific frequency, 2800-3100 cm^{-1} , are attributed to the C-H stretching vibration of the hydrophilic section of fatty acids, the vibration of –CH$_2$-CH$_2$ – at 2918cm^{-1}and –CH$_2$-CH$_3$ at 2851 cm^{-1}.

In another references[21], the symmetric and asymmetric vibration of -C-H (CH$_2$) has been identified in this frequency. The bending vibration modes of CH$_2$ in plan and also out of plan deformation, wagging, rocking and twisting usually occur in the region 1430- 715 cm^{-1}. The band at 724 cm^{-1}is also observed in the other fatty acids spectra due to bending vibration of –(CH$_2$)$_n$ and also HC=CH- in cis formation. Therefore, the presence of unsaturated hydrocarbon fatty acid is also not rejected. The FT-IR spectrum of soap is also provided in Figure 4.

In this spectrum, the stretching vibration of hydroxyl groups appears in a broad band centered at 3359 cm^{-1}. The strong band at 2921 cm^{-1} is attributed to the stretching vibration of CH$_2$ functional group of this amine. In the spectrum of the new surfactant, Figure 4, the ester carbonyl group, usually at ~1738 cm^{-1} is not observed, however at 1555 cm^{-1} the specific band has been identified. According to the studies, the produced salt has been approved. Therefore. it was conjectured that the attachment between fatty acids and the identified group in ethanol has led to the soap formation. The stretching vibration of –COO group in soap was determined at this region[22] 1530 – 1580 cm^{-1}. In the samples with 100% naturalization in salt form, a bond due to –COO group occurs at 1554.7 cm^{-1}. As it has been indicated in another work[21], by increasing the amount of tri-ethanol amine in the fatty acids, this band would appear at a higher frequency. The products can be identified as a set of tri-ethanol soap or complex of acid soap with desirable activity as a surfactant. The bending vibration of the CH$_2$ group attached to the –COO soap is found to be at 1409.38 cm^{-1}. The symmetric oscillation of CH$_2$ at the end of the chain bonded to the CH$_3$is found at 1099.10 cm^{-1}. The predicted chemical structure is provided in Scheme1.

### The fatty acid analysis using GC-MS

In this analysis, about 40 different fatty acids were detected, only some of them with high level of percentage are indicated in Table 1, more than 80% of the fatty acids extracted from the chicken skin were detected with long chain alkanes with carbon atoms in the range of 14-20 which are suitable for amphophilic section of surface active agents.

Critical micelle concentration

The concentration at which the first micelles are formed is called critical micelle concentration (CMC). A micelle is defined as an aggregation of a large but not infinite number of surfactant monomers in the solution. The value of CMC is an important parameter in a wide variety of industrial applications. The characteristics of colloids and surface behavior of surfactant solutes can be explained using this parameter. The concentration of surfactant at this point can facilitate the adsorption of surfactant molecules at the interface to produce a different system such as a foam, emulsion, suspension or surface coating. The measurement of bulk solution properties such as surface tension, electrical conductivity or light scattering as a function of surfactant concentration will produce curves that normally exhibit relatively sharp discontinuities at comparatively low concentration which can be identified as a critical micelle concentration. In the case of synthesis of emulsifiers, the variation of electrical conductivity, turbidity and surface tension as a function of surfactant concentration are shown in Figure 5. The value of this parameter CMC can be empirically determined from the data. The required amount of surfactant to achieve the CMC has been determined to be about 0.6-0.7 % on basis of the weight of the emulsion. The surface tension is reduced by increasing the concentration of emulsifier used in W/O emulsion system, Figure 6.
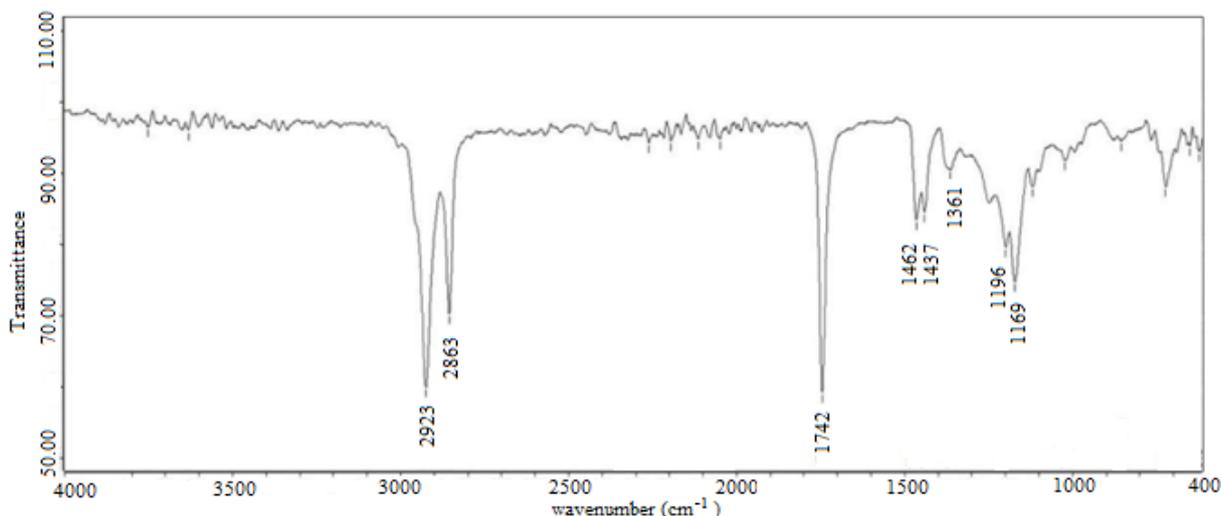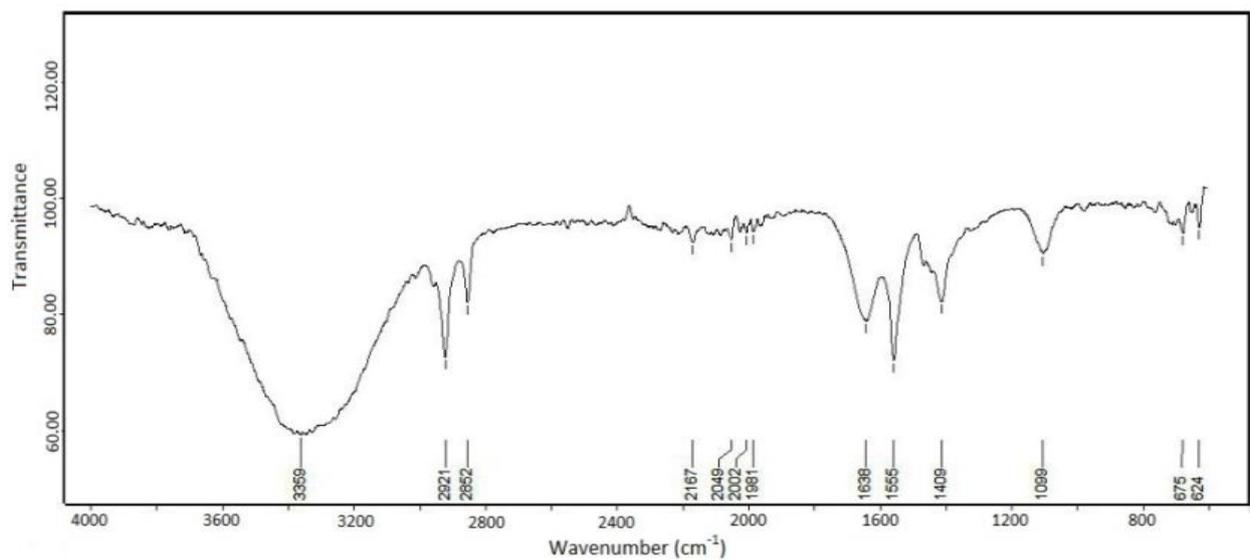

Figure 1: The FT-IR spectrum of fatty glycerol extracted from the chicken skin.
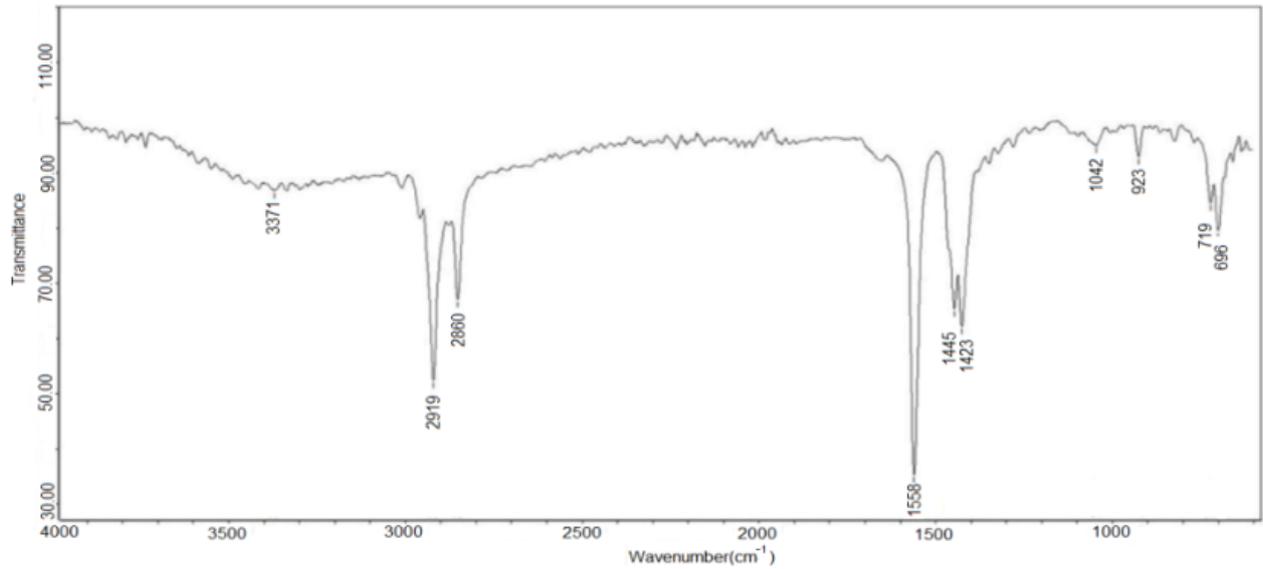
Figure 2: The FT-IR spectrum of the soap produced from the fatty glycerol.
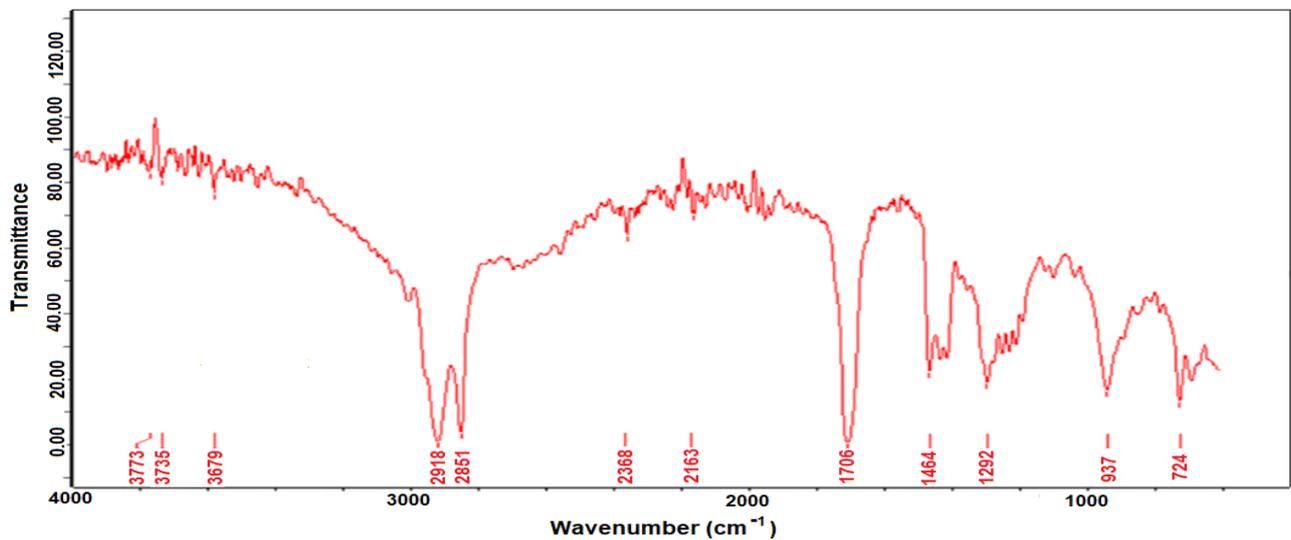
Figure 3: The FT-IR spectrum of fatty acid extracted from chicken skin.

Figure 4: The FT-IR spectrum of tri-ethanolamine soap provided from the chicken skin fatty acids.

The stability of an emulsion

The breaking of an emulsion occurs when the droplets coalesce to form large droplets. This is a result of the system decreasing its free energy until eventually, the dispersed phase separates from the continuous phase and the emulsion breaks. This behavior depends on a number of parameters such as the physical nature of the interfacial film, the presence of an electrical or steric barrier on the droplets, droplet size distribution, continuous phase viscosity, phase volume ratio and temperature. The interfacial film in W/O macro emulsion, in particular, must be very strong. The intermolecular force and well orientation, with respect to the interface, provides a film with good rigidity. In this W/O emulsion, when there is no electrical barrier to coalescence, mainly mechanical strength of the interfacial film protects the stability of the emulsion. To find the required amount of surfactant to have a stable emulsion, various amount of new emulsifier, 0.5, 1.0, 1.5 and 2 % were used in this experiment. All tests were carried out at room temperature. These results are shown in Figure 7.

The optimum stability of an emulsion can be achieved due to the competing role of repulsive structural versus attractive depletion forces. In the presence of an alcohol in an emulsion the interaction between water droplet and alcohol produce the interfacial active solute. The new structural force induces a repulsive energy barrier which enhances emulsion stability. In this case, the liquid in which the surfactant is more soluble becomes the continuous phase. In the experiment using isopropyl alcohol, at the beginning, the emulsion stability against sedimentation was improved until 10 days, after that stability did not differ significantly and only 5% reduction was observed in comparison with a solution without alcohol. The stability of the provided emulsion was indicated after ten days and remained unchanged for further 20 more days, Figure 8.

The droplet size distribution also has a significant impact on the stability of an emulsion. The large particles have less interfacial surface per unit volume than small droplets. In fact, an emulsion with a firmly uniform droplet size distribution is more stable than one with the same average particles size with broad size distribution. In this work, the number of carbon atoms forming the most fatty acids were used in the alkyl chain of a surfactant is variable in a given range, because of that the similarity of surfactant length is announced.

The salinity of water is also studied through this work. NaCl salt was added to the solution in 1/1 v/v of water and paraffin, 2% emulsifier, mixing at 750 rpm for 5 minutes in the presence of 5, 10 and 15 g/lit of salt. The stability of the emulsion was monitored for 1 month. These results are provided in Figure 9.

The emulsifier in the system is soap with carboxylic group. Therefore, in the water phase it plays as an electrolyte and can have a significant effect on W/O emulsion stability. The level of NaCl was increased from 5 to 15g/l. At low levels of salinity up to 10 g/l of salt in the solution, separation did not occurr and no difference in stability was measured for a long period of time. At high levels of salt used in the emulsion, 15 g/l, the ionic formation around each water molecule had an effect on the interfacial film strength.

In this system, the micelle formation between phases was stable for 10 days and also more emulsion stability was observed. In fact, the establishment of a strong fat crystal network within the continuous phase of a W/O emulsion was responsible for retarding droplet
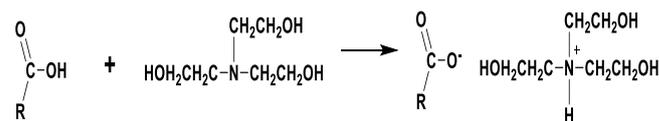
Scheme 1: The predicted chemical structure of the synthesized compound.

movement. However, at a longer time, suddenly with all the new ion formation from the electrolyte around micelles, the system is destructed.

In a macro emulsion the phase volume ratio is also important. When the volume of the dispersed phase increases, the interfacial film surface expands further and further to the droplets of the dispersed material and finally the emulsion instability occurs. Therefore, in this experiment, three various systems with different volume ratios of oil and water were prepared with the same amount of emulsifier, 2%, and similarconditions of mixing velocity and time. The best conditions were achieved in 1/3 ratio of water to oil. It is necessary to mention that for each experiment, depending on the evaluated parameters, various types of colorant were used to measure the level of interfacial film properly. Since in this study the comparison of each parameter was undertaken separately, the effect of the colorant on stability of an emulsion can be ignored, as can be observed in Figure 10.

The effect of mixing conditions on stability of the prepared emulsion with the new surfactant was also studied. The selected velocities include all the stirrer operational range, 250, 750 and 1250 rpm, and the mixing time of agitation for 5 and 10minutes. In all systems, the volume of water and oil were similar, with 2% surfactant. The information regarding the emulsion stability prepared in various mixing conditions is indicated in Figure 11. The emulsion that presented the lowest separation was produced with the speed of stirrer set to 1250 rpm. However, the reduction in mixing velocity is favorable not only because of the stability but also in operational cost. The 5 minutes of agitation at high speed 1250 rpm showed the best stability for one month; a longer mixing time is not recommended.
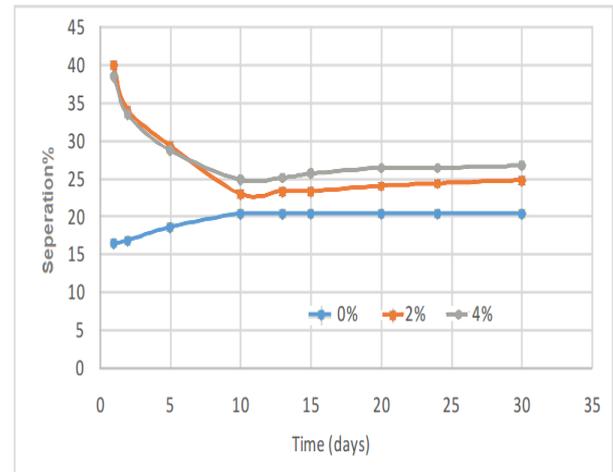
The viscosity of emulsion

The effect of temperature on the mechanical strength, elasticity and the rheological properties of interfacial film stability in an emulsion are well known. The nature and viscosity of the interfacial film, the solubility of the emulsification, vapor pressure and the viscosity of the liquid phase can be changed in various temperatures. In conclusion, considerable changes in the emulsion stability would be expected. The effect of shear rate data on viscosity and also on the stability of volume percentage of water/oil emulsion is plotted in Figure 12. It is obvious that over a range of shear rate, from 20 to $100s^{-1}$, the apparent dynamic viscosity as a function of shear rate decreased with increasing the temperature from 25 to 70°C. All the provided emulsions were found to follow shear thinning behavior, "pseudo-plastic". The effect of water content on viscosity of W/O emulsion stabilized with new emulsifier (2%) at different rotational speeds is presented in Figure 13. For the water/paraffin emulsion containing (50 vol%) water, the viscosity was measured 2000 cp at 1250 rpm in room temperature. However, when the water content reduced to 20 vol%, the viscosity was reduced at the same testing conditions.

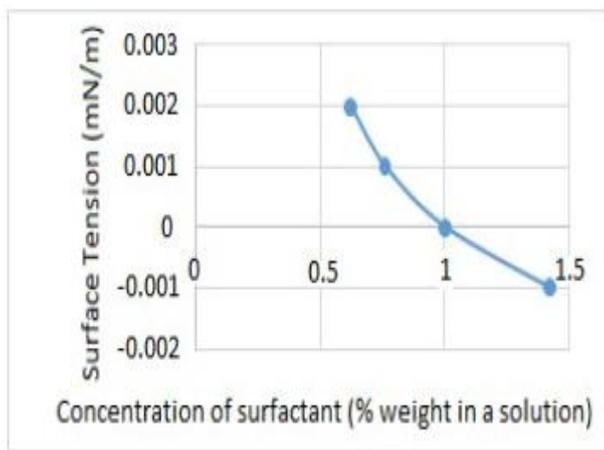**Table 1:** The name of a few fatty acid detected using GC-MS analysis.

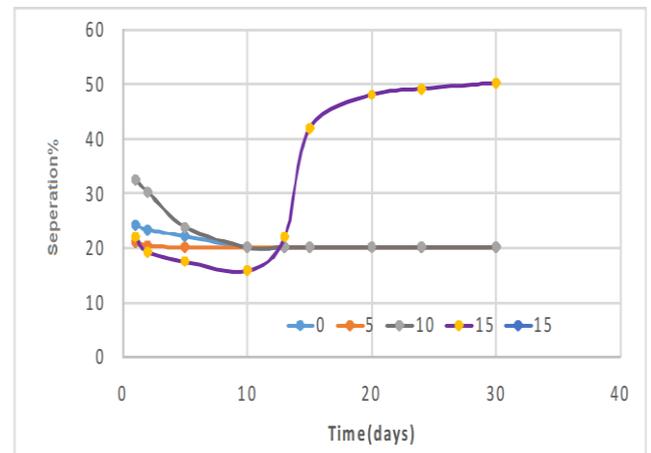| Name	Molecular formula	Chemical structure	%
n-Hexadecanoic acid	$C_{16}H_{32}O_2$		29.59
10,13-Octadecadienoic acid	$C_{18}H_{32}O_2$		28.31
Trans-9-Hexadecenoic acid	$C_{16}H_{30}O_2$		8.30
Tetradecanoic acid	$C_{14}H_{28}O_2$		7.82
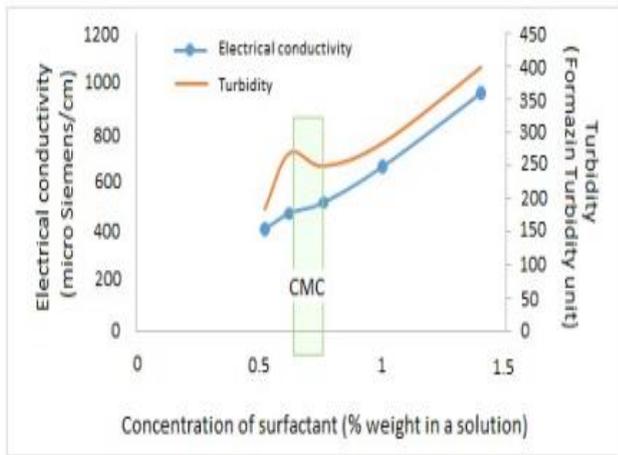
Figure 5: The variation of electrical conductivity and turbidity as a function of surfactant concentration for the prepared emulsion, the volume ratio of paraffin and water was 1, mixing velocity 750 rpm and mixing time 5 minutes.

Figure 6: The value of surface tension as a function of applied surfactant concentration, the volume ratio of paraffin and water was 1, mixing velocity 750 rpm and mixing time 5 minutes.

Figure 7: The effect of surfactant content on emulsion stability, the volume ratio of paraffin and water was 1, mixing velocity 750 rpm and mixing time 5 minutes.
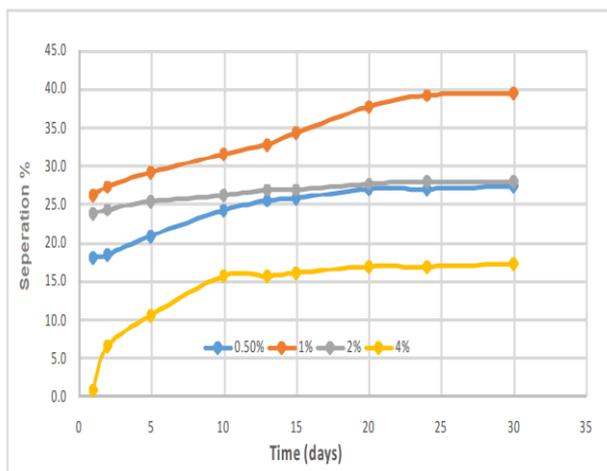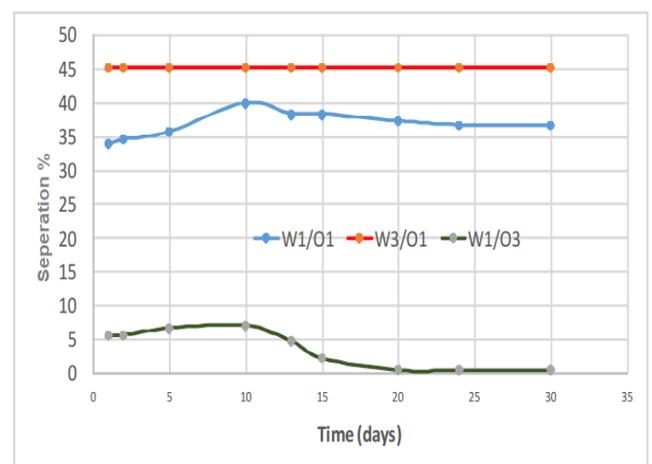

Figure 8: The effect of alcohol on the stability of an emulsion, the volume ratio of paraffin and water was 1, 2% of surfactant, mixing velocity 750 rpm and mixing time 5 minutes.
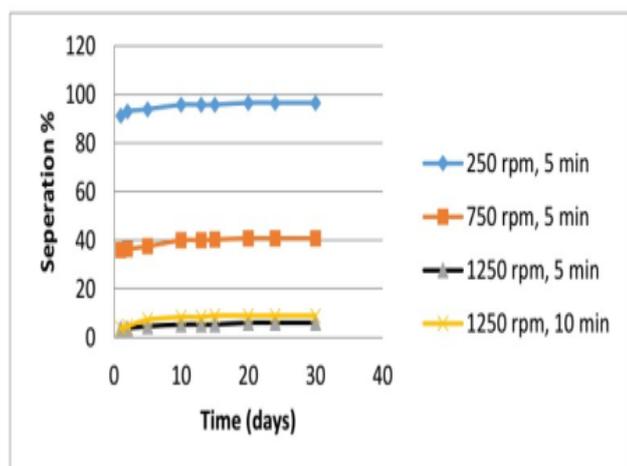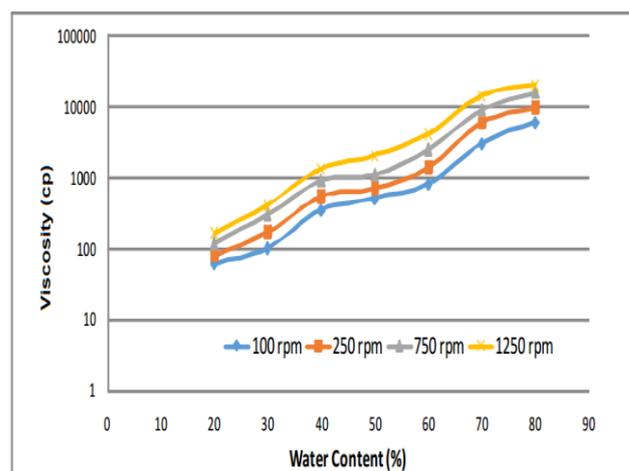

Figure 9: The effect of water salinity on the stability of an emulsion, the volume ratio of paraffin and water was 1, 2% of surfactant, mixing velocity 750 rpm and mixing time 5 minutes
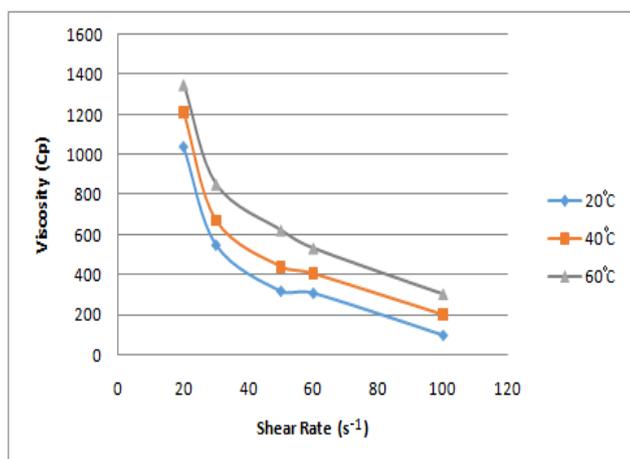

Figure 10: The effect of different volume ratio of oil and water in stability of an emulsion, using 2% of surfactant, mixing velocity 750 rpm and mixing time 5minutes.

Figure 11: The effect of mixing conditions, the agitation velocity and time of mixing on stability of an W/O emulsion, using 2% of surfactant, mixing velocity 750 rpm and mixing time 5minutes.

Figure 12: The effect of shear rate on viscosity of prepared W/O emulsions, the volume ratio of paraffin and water was 1, containing 2% of surfactant, mixing at various velocity speed, for 5 minutes.


Figure 13: The effect of water volume fraction on viscosity of W/O emulsion stabilized with new surfactant (2 Vol. %) prepared at different rotational speeds.

The size of water droplets in an oil phase
In W/O macro emulsion, the surrounded film around water droplets must be very strong. These films are believed to be similar to solid condensed type due to the very strong intermolecular forces and being very well orientated which provides the rigidity of the film. In W/O emulsion, in the interfacial film between water and oil no electrical charge was produced, therefore no electrical barrier to coalescence was predicted. In fact, the mechanical strength of the interfacial film can protect the emulsion from coalescence. A microscopic image of the droplets of water dispersed in the paraffin oil phase is provided, the water to oil ration was 1/3, containing 2% of surfactant on the whole volume of the mixture. In Figure 14(a), the emulsion sample was studied after 3 months of preparation with a total magnification of 450 times of original size and in Figure 14(b), the picture was taken after 20 months with 1800 times total magnification. The purpose of this study was to determine the size of water droplets. As seen in the picture, after a long time, the stability of an emulsion is still favorable and the amount of water droplets is smaller. The distribution of water in the oily phase is clearly visible.
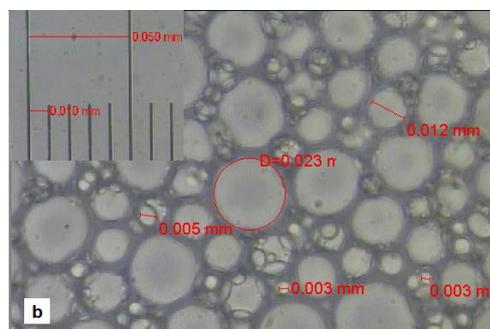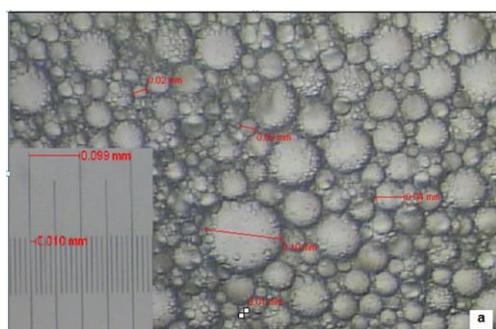
Figure14: A micrograph picture of an emulsion prepared from 1 part of water to 3 parts of oil, containing 2% of surfactant on the volume of mixture. (a) After 3 months, with 450 times magnification and (b) after 20 months with 1800 times magnification.

Conclusion

The effectiveness of surface activators in cosmetics, pharmaceutical and food industries, and the sensitivity of the body in contact with them create limitations for the raw materials used in the preparation of these compounds. It is recommended that natural materials should be used for their production. Chicken skin as waste materials can be a good source for these products. The extra fat is about 32% by weight, which is easily extracted by heating at 80°C. The most fatty acids extracted from the chicken skin were detected with long chain alkanes with carbon atoms in the range of 14-20, structure that is ideal for the hydrophobic part of a surface activator.

In this study, this type of fatty glycerol was used as a raw material for producing surfactants. The chemical constituents of the extracted fatty glycerol from chicken skin were determined by GC-MS. The saturated and unsaturated fatty acids were identified in varied percentage, where octadeanoic acid, octadecadieonic acid and hexadecanoic acid can be mentioned. The total fatty acids in this reaction were converted to the salt of soap. This soap has been identified as water in oil emulsifier. The stability of their emulsion over time was investigated in the presence of salt, alcohol. Other variables such as amount of activator, water volume to oil ratio, speed and stirring time can also affect the stability of the emulsion in the long run, which has been studied. The activator produced with total acidity was found to be an excellent emulsifier. This work was the perfect starting point for the application of this fatty glycerol for producing various types of surfactants with different chemical properties that can be tailored for cosmetics, cosmeceuticals, shampoos, skin care formulations and other personal care products.

Conflict of interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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