

Physicochemical and Sensory Properties of Traditionally and Laboratory Made Ghee (*Samin*) of the Sudan

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Abstract Samin is traditional cooking oil produced using the butter made from the milk of sheep, cow or goats. The objectives of the study was the determination of the physical, chemical and sensory characteristics of samin samples collected from local market, preparation of Samin at the laboratory level and evaluation its quality. The moisture content, acid value (mgKOH/g), free fatty acids and peroxide value ranged $0.03 \pm 0.05\%$ - $0.34 \pm 0.05\%$, 0.56 ± 0.0 , - 1.94 ± 0.17 (mgKOH/g), 0.28 , $-0.97 \pm 0.09\%$, 9.93 ± 0.23 - 2.60 ± 0.40 (mEq/kg) in the various samin samples. However, the saponification value, density, viscosity, melting point and refractive index of the different samin samples ranged 165.50-172.23 (mgKOH/g), $0.925-0.913$ g/cm³, 0.519×10^{-3} - $0.335 \times 10^{-3} \pm 0.02$ pa.s, 38-37 °C and 1.4600-1.4582, respectively. The sensory evaluation revealed there was no-significant difference in texture, color, and overall acceptability of the samples, but there was significant difference ($p \leq 0.05$) in flavour, between LMS sample and the other samples. It is highly recommended to improve production of samin under controlled hygienic conditions.

Keywords Quality, Peroxide Value, Viscosity, Density, Refractive Index, Flavor

1. Introduction

The health benefits of milk can be achieved from milk directly or its products such as cheese, butter, curd, clarified butter or ghee, dairy whitener, ice cream, cottage cheese or paneer, flavored milk, milk sweets etc. The US Department of Agriculture (USDA) has clearly mentioned in its Dietary Guidelines to include milk and milk products in the diet[1].

Milk fat is the major source of energy, since prehistoric times, man has satisfied his need for fat by eating foods from a variety of animal and vegetable sources. Among these foods milk from animals has been a prime source of nutrients. Traditionally milk fat has always had the highest economic value of any of the milk constituents, placing it at an economic disadvantage to other edible fats and oils products[2].

Samin is a traditional cooking oil most common in North African and Middle Eastern countries. It is produced using the butter made from the milk of sheep, cow or goats. Also called Ghee in Indian cuisine. Ghee is clarified butter that has been cooked longer to remove all the moisture, and the milk solids are browned (caramelized) in the fat and then strained out. This gives a rich nutty taste. Ghee has a longer shelf life, both refrigerated and at room temperature[3].

The people in Sudan use milk to make *Samin* but some of them use butter to make it. The production of *Samin* is found in many parts of Sudan and they use many ways of making it, some people put the fermented milk in a container and jerk it hard for a long time until they find *Samin* in the face of the container. Others put the milk on the fire and after that put it in a cool place, and they take the thick part from the top of the milk for some days after some days boiling it to obtain *Samin*. *Samin* is a nutritious food product that holds great cultural significance, particularly as an indicator of familial wealth in Sudan. The major use of *Samin* among those who produce it, namely the nomads, is as a topping for *mulah*, however many of these people simply drink *Samin* as it is, in small quantities such as a coffee cupful every morning. *Samin* is also given to children either pure or mixed with some food, sometimes pure *Samin* is used as a relish or sauce in the Northern and Nile Provinces, also the practice of topping coffee and tea with floating *Samin* is well known in the Sudan. *Samin* is even given to highly valued pet animals, such as horses. The objectives of the study include the determination of the physical, chemical and sensory characteristics of *Samin* samples collected from local market and to produce, preparation of samin at the laboratory level and evaluation of its quality.

2. Materials and Methods

2.1. Materials

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Thirty *Samin* samples were obtained from local markets in Medani, Elobied and Rofaa cities in Sudan (10 sample from each) during the period January – February 2011, and another sample was prepared at laboratory level. All of these samples were transferred to laboratories of the Department of Food Science and Technology, Faculty of Engineering and Technology, University of Gezira for analysis.

2.2. Preparation of *samin* at Laboratory Level

For preparation of *samin* at laboratory level, a *Robe* inoculum (starter culture) was added to fresh cow milk and the fermentation process was allowed to proceed for overnight to produce fermented milk (*Robe*). Then the butter was separated by centrifugation. The collected butter was then boiled to remove excess water to obtain the laboratory made *samin* (LMS).

2.3. Physicochemical properties of *Samin*

The moisture content of various samples was determined according to the AACC methods[4].

The free fatty acids of the samples were determined according to the AOAC methods[5]. Five grams of *Samin* weighed into conical flask added 25 ml diethyl ether, 25 ml alcohol (ethanol) and 1 ml of phenolphthalein solution (1 percent) and carefully neutralize with 0.1 M sodium hydroxide shaking constantly until a pink colour is obtained. The acid value was calculated from the following equation:

$$\text{Acid value} = \frac{\text{Titration (ml)} \times 5.61}{\text{Wt (gm) of sample used}}$$

The Peroxide value and saponification number of the different samples were determined according to AOAC[6] methods, while the density, viscosity were determined according to Dardiri[7]. On the other hand, the melting point was determined according to AOCS[8] method. The Refractive index of the samples was determined by Refractometer.6

2.4. Fatty Acid Composition

Fatty acid composition of the different *samin* samples was analyzed by gas liquid chromatography (GLC) using capillary column.

Five drops from each sample was dissolved using 5 ml hexane and shaken, then 1 ml of esterification solution was added. The analyses were performed using a gas chromatography model GC 3380 with ADCB detector and coupled to a 3396 H-p integrator and a 50-m fused silica capillary column of 0.25 mm internal diameter, coated with cyanopropyl- polysiloxane as stationary phase. Cp-Sil 88 of (Chromopack) was used. The majority of analyses were performed operating under isothermal conditions. The chromatographic conditions were:

Oven temperature	195°C
Injector temperature	250°C
Detector temperature	250°C

Flow of carrier gas (helium) 1-2/sec

Identification of chromatographic peaks was carried out by comparison of their retention times using appropriate standards of fatty acid methyl esters.

2.5. Sensory Analysis

Samin samples were subjected to sensory evaluation (Hedonic scale) using 15 panelists. The panelists were asked to assess each sample for texture, flavor, color and overall acceptability using a questionnaire designed by the Department of Food Science and Technology. All analysis took place in a room free from distributing noises, with uniform intensity levels of lighting; fresh air was provided with water for rinsing. All those conditions were equally used for all tests. The order of presentation of samples was randomized and the samples were given codes before being tested, the results were recorded and analyzed.

2.6. Hedonic Test

Ten judges were selected to express their preference of *Samin* sample. The samples were presented so that each sample had equal chance to be tasted first or second. The results obtained by the panelists were converted to MSTAT [9]. The scores were subjected to statistical analysis.

2.7. Statistical Analysis

The scores obtained by the panelists in hedonic test were subjected to analysis of variance at 5% level according to MSTAT[9], to determine whether there were significant different means for each variable; (F-test) was used.

3. Results and Discussion

3.1. Physicochemical Properties of *Samin* Samples

The physicochemical properties of *samin* samples is presented in Table (1). The moisture contents of Medani, Rofaa, Elobied and laboratory made *samin* (LMS) samples were $0.08 \pm 0.06\%$, $0.34 \pm 0.05\%$, $0.03 \pm 0.05\%$ and $0.33 \pm 0.06\%$, respectively. These values are within the recommended Codex Standards for ghee (0.3%), however, Bille and Ngwira[10] also found that the moisture content of traditional ghee in Namibia ranged between 0.2 – 0.46% .

Acid value of Medani, Rofaa, Elobied and LMS samples was 0.56 ± 0.0 , 1.42 ± 0.07 , 0.64 ± 0.17 and 1.94 ± 0.17 , respectively. The highest value was found in LMS sample, while the lowest value was reported in Medani's samples. The value of acid of *samin* could be increased as a result of contamination during its preparation or handling. The presence of lipase and oxygen naturally found in the milk may have already attacked and hydrolized the butter fat butterfat globules in the milk of all species. It can be separated to make butter. The nutritional value and the price of milk are judged on, among other things, the butterfat content of the milk. into free fatty acids (rancid) and oxidized flavours (cardboard flavour) before butter was

boiled into ghee (Bille and Ngwira, 2001). The free fatty acids of Medani, Rofaa, Elobied and LMS samples were 0.28 ± 0.0 , 0.71 ± 0.06 , 0.31 ± 0.09 and $0.97 \pm .09$ respectively.

The Peroxide values were 9.87 ± 0.31 , 2.60 ± 0.0 , 9.93 ± 0.23 and 2.60 ± 0.40 for Medani, Rofaa, Elobied and LMS samples, respectively. Okullo[11] found that the peroxide values of ghee butter in Pader, Lira, Katakwi and Arua districts were 2.25 ± 0.35 , 2.20 ± 0.42 , 2.10 ± 0.14 and 2.50 ± 0.71 , respectively. The peroxide value in Medani and Elobied sample was very high according to these results. The increase in peroxide value could be attributed to the oxidation of fatty acids due to several factors like high temperature, packing in containers impermeable to light and loose lock in addition to poor storage and poor handling[12].

The saponification value has been useful screening test for quality control and characterizing types of fats and oils. The Saponification values of Medani, Rofaa, Elobied and LMS samples were 165.50, 172.23, 171.11 and 163.81, respectively. The obtained values were lower than that reported by O'Brien[2], who found that the saponification value of milk fat ranged from 210 to 250. It is known that fats containing short-chain fatty acids have higher saponification value than those with longer chain fatty acids., according to their physical properties obtained, samini can be classified as a semi solid fat.

3.2. Fatty Acid Composition

Fatty acids mostly originate from the hydrolysis of the milk fat. The lipase responsible for their production probably

originates from the milk itself[13]. Results of fatty acids composition of collected sample are presented in Table 2.

The fatty acids composition of all samples varied but the common fatty acids found in samples were lauric (C12:0), myristic (C14:0), oleic (C18:1) and palmitic acid (C16:0). Palmitic acid is one of the major saturated fatty acids it raises serum cholesterol, while stearic acid does not. The saturated fatty acids found in Medani sample were capric, lauric, myristic, palmitic and arachidic while unsaturated fatty acids were oleic and linoleic, while saturated fatty acids found in Elobied sample were lauric, myristic and palmitic and unsaturated fatty acids were oleic and linoleic. The saturated fatty acids found in Rofaa sample were caprylic, capric, lauric, myristic, palmitic, stearic, arachidic and margaric but unsaturated fatty acids were oleic and linoleic, also the unsaturated fatty acids found in LMS sample were oleic and arachidonic while the saturated fatty acids found in the sample was caproic, caprylic, lauric, myristic, palmitic, stearic, arachidic, margaric and behenic. The fatty acids composition can be influenced to a limited extent by the fodder of the animals. Milk fats contain remarkable amount of short chain fatty acids ranging from C4 to C10[13]

The results of density, viscosity, melting point and refractive index of the various *samin* samples are presented in Table (3). The density of Medani, Rofaa, Elobied and LMS samples were 0.925, 0.909, 0.923 and 0.913, respectively. The obtained results are in close agreement to those reported by Erickson[14] for the density value of edible animal fat (lard) which ranged from 0.896 to 0.904.

Table 1. Chemical composition of *samin* samples

Parameter Source	Medani <i>samin</i>	Rofaa <i>samin</i>	Elobied <i>Samin</i>	LMS
moisture content%	0.08 ± 0.06	0.34 ± 0.05	0.03 ± 0.05	0.33 ± 0.06
Acid value(mgKOH/kg)	0.56 ± 0.0	1.42 ± 0.07	0.64 ± 0.17	1.94 ± 0.17
free fatty acids%	0.28 ± 0.0	0.71 ± 0.06	0.31 ± 0.09	$0.97 \pm .09$
Peroxide value(mEq/kg)	9.87 ± 0.31	2.60 ± 0.0	9.93 ± 0.23	2.60 ± 0.40
Saponification value(mgKOH/g)	165.50	172.23	171.11	163.81

Means of samples \pm SD

Table 2. Fatty acids composition in different *Samin* samples

Medani,	Elobied	Rofaa	LMS
capric	lauric	Caprylic	Caproic
lauric	myristic	Capric	Caprylic
myristic	palmitic	Lauric	Lauric
palmitic	oleic	Myristic	Myristic
oleic	linoleic	Palmitic	Palmitic
linoleic	_____	Stearic	Stearic
arachidic	_____	Arachidic	Arachidic
_____	_____	Oleic	Oleic
_____	_____	Linoleic	Arachidonic
_____	_____	Margaric	Margaric
_____	_____	_____	Behenic

LMS=Laboratory made *Samin*

Table 3. The density, viscosity, melting point and refractive index of the various *samin* samples

Sample	Medani	Rofaa	Elobied	LMS
Density (g/cm ³)	0.925	0.909	0.923	0.913
Viscosity (pa.s)	0.519*10 ⁻³ ±0.0	0.307*10 ⁻³ ±0.0	0.551*10 ⁻³ ±0.0	0.335*10 ⁻³ ±0.02
Melting point °C	38	37	38	37
Refractive index	1.4600	1.4582	1.4590	1.4598

Means of samples ±SD

LMS=Laboratory made *samin*

The viscosity of fats and oils decreases slightly with an increase in unsaturation, therefore viscosity is increased slightly by hydrogenation. Oils and fats containing a greater proportion of fatty acids of relatively low molecular weight are slightly less viscous than ones of an equivalent degree of unsaturation, but containing a higher proportion of high molecular weight acids[15]. The values of Medani, Rofaa, Elobied and LMS samples were $0.519 \times 10^{-3} \pm 0.0$, $0.307 \times 10^{-3} \pm 0.0$, $0.551 \times 10^{-3} \pm 0.0$ and $0.335 \times 10^{-3} \pm 0.02$, respectively. The highest value was found in Elobied sample but the lowest value was reported in Rofaa's sample.

The melting point is an important physical characteristic of fatty compounds which is useful for identification and important in many technological applications of fatty materials. The melting points of fatty acid increase with increasing chain length and decrease as the acids become more unsaturated[16]. Melting points of Medani, Rofaa, Elobied and LMS samples were 38, 37, 38 and 37°C, respectively. These results were within the range reported by O'Brien[2] for melting point of milk fat (36-38 °C).

The refractive index is related to the ease with which light passes through the fat. Temperature and degree of saturation affect the value. Butter's refractive index value can be used as an indirect measurement of unsaturation.[17]. Refractive index of Medani, Rofaa, Elobied and LMS samples were 1.4600, 1.4582, 1.4590 and 1.4598, respectively.

3.3. Sensory Evaluation

Table 4. Mean score for sensory attributes of various samples of *samin*

Sample	Flavor	Texture	Color	Over all acceptability
Medani	4.10 ^a	6.50 ^c	5.30 ^d	4.60 ^e
Rofaa	5.10 ^a	6.40 ^c	6.50 ^d	4.50 ^e
Elobied	4.30 ^a	6.80 ^c	5.30 ^d	5.00 ^e
LMS	6.70 ^b	6.20 ^c	6.90 ^d	6.30 ^e

* LMS=Laboratory made *samin** Any two mean values having different superscript letter(s) in each column differ significantly ($p \leq 0.05$)

A sensory evaluation was carried out by the senses of taste, smell, touch, and hearing when food is eaten. The complex sensation that results from the interaction of the senses is used to measure food quality in programs for quality control and new product development[18]. The results of the sensory evaluation (Table 4) show that all *samin* samples were accepted by the panelists. There was no-significant difference in texture, color, and overall acceptability of the

different samples but there was significant difference ($p \leq 0.05$) in flavor, between LMS samples and the other samples.

4. Conclusions

The research was carried out to assess the chemical and physical characteristics of *samin* samples obtained from selected markets in the Sudan and to compare them with those of laboratory made *samin* (LMS). The results of the chemical composition of different *samin* samples indicated that most of the chemical components of the samples were relatively lower when compared with those of laboratory made *samin* (LMS) sample. On the other hand, the physical characteristics of different *samin* samples were similar to those found in the laboratory made *samin* (LMS) sample; and also these physical characteristics of samples were within the range of the study carried out. The sensory analysis indicates that all types of *samin* were accepted by panelists. Most panelists preferred the *samin* due to its color, appearance and texture not due to flavor. The study indicates that *samin* which is semi solid product has a high nutritive value.

It is highly recommended to improve the technology of *samin* preparation under hygienic conditions and using good manufacturing practices..

REFERENCES

- [1] www.organicfacts.net/health-benefits (2010).
- [2] O'Brien, R.D. (1998). Fats and oils formulating and processing for applications, pp39.
- [3] http://whatscookingamerica.net (2010).
- [4] AACC (1983). Approved Methods of Analysis American association of Cereal Chemist, st. Paul, MIN. USA.
- [5] AOAC (1980). Official Method of Analysis. Thirteenth Edition. Association of Official Analytical Chemists, Washington, DC.
- [6] AOAC (2005). Association of Official Analytical Chemists. Official Methods of Analysis, 18th Edition, AOAC Press, Washington DC.
- [7] Dardiri, M.M. (1985). Laboratory Experiments for Food Analysis pp83-93.

- [8] AOCS. (1995) American Oil Chemists Society Official and Tentative of American Oil Chemists Society 2nd Aosc-Champaign Illinois.
- [9] MSTAT (1982). Michigan State University. East Lansing, MI, USA
- [10] Bille PG, Ozuuko ATR Achilles tendon reflex, see Ankle reflex and T Ngwira .(2001)Sensory properties of traditionally-fermented buttermilk (Omashikwa) processed in Namibia. J. Food Technol Africa; 7: 52-54.
- [11] Okullo.J. B (2010). Physico-chemical characteristics of shea butter (Vitellariaparadoxa C.F. Gaertn.) oil from the shea districts of Uganda Volume 10 No. 1 Ajfand online.
- [12] Ibrahim.M.K, EL-Batawy M.A, Elsayed.S.A (1986) Comparative studies of gamma irradiated fatty products . Egyptian J . Dairy Sci, 15:221-228.
- [13] Stadhouders, J, HUP.G. Exterkte, F and Visser.S (1983) Mechanism of formation of the bitter flavor detected in cheese. Neth.Milk Dairy .J. 37:67-157. <http://www.eatwisconsincheese.com>, 2010.
- [14] Erickson.D.R (1990) Edible Fats and Oils Processing, Basic Principles and Modern Practices, Illionis.
- [15] Lawson.H. (1995) Food Oils and Fats, Technology, Utilization and Nutrition p 35.
- [16] Perkins.E.G and Visek.W.J(1983) Dietary Fats and Health. The University of Illinois Urbana, Illinois
- [17] <http://www.eatwisconsincheese.com>, 2010.
- [18] Larmone, E. (1982). Laboratory Methods for Sensory Evaluation of Food Ministry of Supply and Services. Canada p 20-22-65-58.