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Preparation of Liquid Soap from Sheep's Tail Fat

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Abstract

The aim of this study was to select sheep fat from Tsetserleg sum of Arkhangai aimag as raw material and to produce liquid soap. The oil was extracted from raw materials such as sheep's tail fat (TF), outer fat (OF), and inner fat (IF), which were analyzed by chemical methods, and the liquid soap was obtained by cold methods. Liquid soap was prepared from three types of raw materials, each of which was mixed with 70% fat oil and 30% liquid oil. The ratio was chosen to dilute the liquid soap to 2% of the product. The most suitable oil for preparing liquid soaps from raw materials such as TFO, OFO, and IFO was the tail fat oil (TFO). The highest unsaturated fatty acid content in crude fats and oils was 41.23%, the highest content of saturated fatty acids was 22.3%, and the highest content of methyl-stearate was 33.65% by the GC-MS analytical method.

Keywords

Liquid Soap, Animal Oil, Cold Method, Dilution Ratio, Fatty Acid

1. Introduction

According to the 2020 livestock census of Mongolia, sheep account for 44.8%, goats for 41.3%, cattle for 7.1%, horses for 6.1% and camels for 0.7%. These results show that sheep and goat fats are common and can be found in any season of the year. According to the 2021 survey, our country has 23.2 million sheep. The average weight of a sheep is 23.5 kg, and it is estimated that one sheep can produce an average of 3 - 4 kg of fat [1] [2].

We also noticed that during the slaughter of animals, the inner fat had been ejected, and most households separate and discarded the outer fat when cooking, while households threw away 50% of tail fat. The waste fat has a negative impact

on the environment, but can be used as a raw material for everyday products such as soap. The fat oil becomes suitable raw material because it is a cover that holds in moisture and helps keep skin hydrated [3] [4] [5].

Oils are classified as vegetable and animal fat oil by their derivation. The vegetable oils are liquid state and animal fats are solid state. Animal fat oil contains saturated higher carboxylic acids such as palmitic and stearic acids, while vegetable fats contain unsaturated higher carboxylic acids such as oleic, linoleic, and linoleic acids. Alkaline hydrolysis of fats produces higher carboxylic acid salts, it is named the soaps. This is called a saponification reaction [6]. Sheep tail fat contains a high value of protein. The caloric content of tail fat is 822.5 Kcal, which indicates that sheep tail is included in high-nutrient foods. The melting point of the tail oil is 380˚C, which is lower than that of other oils such as outer fat oil and inner fat oils due to its high content of unsaturated fatty acids [7] [8] [9].

Coconut oil, olive oil, tail oil, and shea butter (shar tos) balance the skin's pH, nourish and moisturize. The addition of essential oils not only adds a natural plant scent but also prolongs the shelf life of the product and has a double antibacterial effect. In addition, the enrichment of organic soaps with biologically active compounds such as essential oils and baragshun can greatly expand the quality, range, and range of applications of the product [10] [11] [12].

Globally, people are embracing eco-consumption, reducing waste, and promoting healthy consumption. They also pay attention to the ingredients of food, daily products, and cleaning products, and reject chemical products [9]. On the other hand, sheep tail fat is an ecologically pure raw material that has been used in the daily life of Mongolians since ancient times and is used in combination to treat some diseases. Therefore, it is necessary to use this wonderful raw material.

Our country imports and sells most consumption of liquid soap [13] [14] [15]. Therefore, the novelty of this study is that we have selected the most common sheep fat in our country as raw material and studied whether it is possible to produce imported liquid soap domestically.

2. Experimental

2.1. Materials

In this study, sheep tail fat (TF), outer fat (OF), and inner fat (IF) *were* used as raw materials from Tsetserleg sum, Arkhangai aimag. The fat samples were washed, cleaned, sliced and melted at 300˚C.

Figure 1 shows how to prepare the samples of sheep tail fat oil (TFO), inner fat oil (IFO) and outer fat oil (OFO), commercial liquid oils (LO1 and LO2) which are the raw materials used in the research.

2.2. Research Methods

The liquid soap test was performed according to the following general scheme. As shown in **Figure 2**, the chemical parameters were determined for each raw material and soap production test phase.

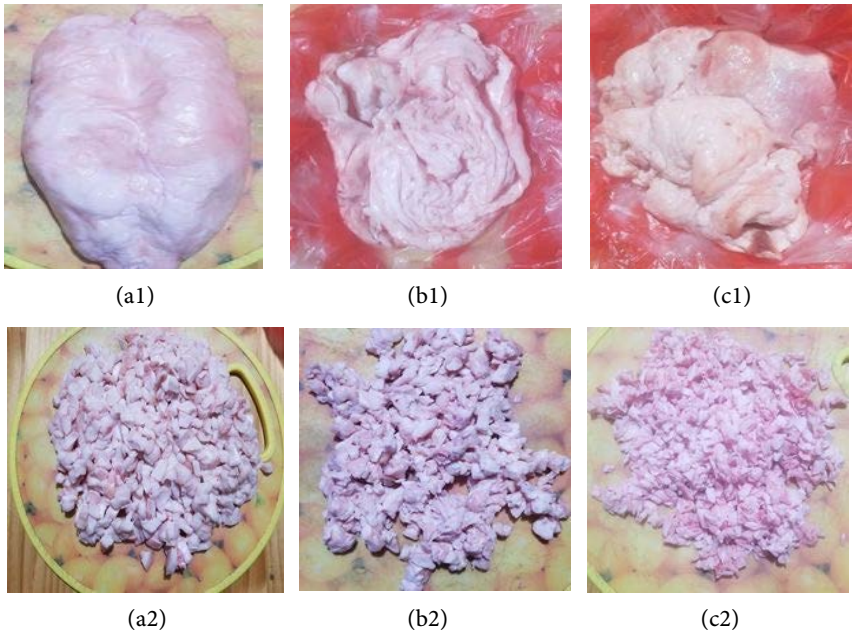

Figure 1. Drawings during sample preparation ((a): tail fat, (b): inner fat, (c): outer fat; indexing 1 is before slice, 2 is after slice).

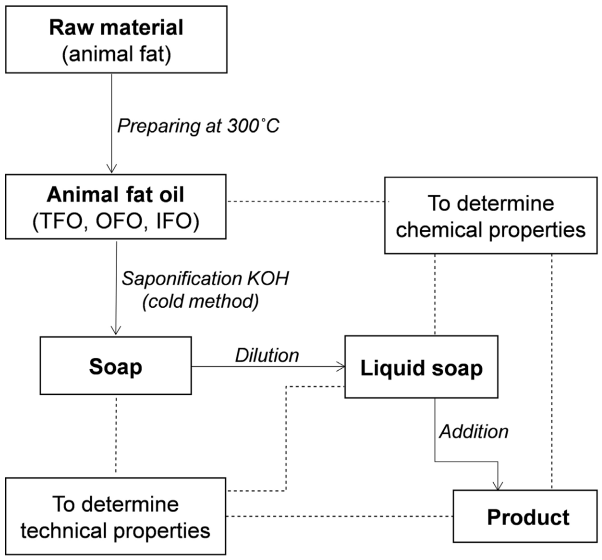

Figure 2. General scheme for production of liquid soap.

In the case of liquid soaps, after the oil has been melted and liquefied, calculate the amount of potassium hydroxide and water suitable for the oil. Dissolve KOH in water and mix the solution and oil at a temperature below 40˚C for 5 min. Cover with a warm blanket the uniformized soap to room temperature, and after 24 h, check the chemical parameters and make further additions. The arrows in this diagram show the sequence of the liquid soap preparing process, and the dashed lines show the analysis of the products obtained from each step. The chemical parameters were determined for raw material and soap products in each step. Density is measured by pycnometer at 20˚C, viscosity is measured by

viscometry at 40˚C, acid number, saponification number and iodine number by titration method, ester number by calculation method, fatty acid by GC-MS instrumental analysis, foam height by self-developed method, which has been described following [6]. Dissolve 1 g of the sample in a glass beaker with a lid of up to 100 ml, measuring the volume to the nearest 1 ml, add 20 ml of water and shake for 1 to 2 minutes. Then immobilize for 10 min, stabilize, and perform the measurement. For measurements, the amount of foaming above the water shall be measured to the nearest milliliter.

Due to the high molecular weight of animal fats, blocking out the narrow capillaries of GC-MS, it can be difficult to determine the content of fatty acids. Therefore, to solve this problem, we converted the oil into an ester with a relatively small molecular mass by transesterification, it with methanol in the presence of an alkaline catalyst [6] [10].

In preparing the liquid soap, we selected the main raw materials for the production of oils TFO, OFO, IFO and LO. When making liquid soap, calculate the amount of potassium hydroxide and water and oil. Calculation per 100 g of oil: The number of saponification of our samples was 0.1786 g.

1) Sheep fat oil 100 g · 0.1786 = 17.86 g/potassium hydroxide.

2) Water contains 100 g · 33% = 33 g/water/. Prepare 70% ice—23.1 g and 30% water—9.9 g.

3) Add essential oil to 1% - 3% of the soap.

Calculate the amount of alkali and water depending on how many grams of oil are used [7].

3. Results and Discussion

3.1. Results of Raw Material Analysis

The raw materials used in the research were tail fat (TF), inner fat (IF), outer fat (OF), and liquid vegetable oil (LO). The chemical parameters of these oils were determined and the results are shown in **Table 1**.

As shown in **Table 1**, liquid oils (LO) were more acidic than animal fats. Also, LO had been contained more unsaturated fatty acids and was soapier. In terms of inner fat, it congeals faster than other oils, so it was the highest viscosity [16].

Table 1. The chemical properties of the oils used to prepare liquid soap.

Chemical properties	TFO	OFO	IFO	LO1	LO2
Acid number, mg KOH/g	1.37	1.52	2.07	7.88	0.078
Saponification number, mg KOH/g	178.6	165.53	191.77	201.11	183.00
Iodine number, %	13.96	2.66	8.25	24.39	6.51
Ester number, mg KOH/g	143.41	164.01	189.7	193.23	182.92
Viscosity, 40˚C, mm^2/cek	39.31	44.82	50.76	45.333	32.57
Density, 20˚C, kg/m^3	0.891	0.924	0.855	0.915	0.875

Preparation of the soap. When preparing soap, it is important to determine the appropriate ratio of raw materials and additives (A), as shown in Table 2.

After processing the raw material at 300˚C and the solids and liquid soaps were prepared as shown in Table 2. Solid and liquid oils were mixed 5 times in different proportions, and the substance was calculated by dissolving the substance in water for each ratio and performing it by the cold method. In addition, based on the appearance of the oil, the ratios of 70:30, 80:20, and 90:10 were selected as the appropriate ratios, and the chemical parameters were further determined.

3.2. Results of GC-MS Analysis of Raw Materials

The number of fatty acids contained in the main raw materials was determined by analytical instruments Gas chromatography-mass spectrometer (GC-MS), in the Institute of Chemistry and Chemical Technology, Mongolian Academy of Science [17].

The unsaturated fatty acid ($C_{19}H_{36}O_2$) in oil extracted from the tail fat was 41.23%, which was higher than the 33.31% and 33.65% in fat oils extracted from the inner fat and outer fat, respectively, as shown in Table 3.

Therefore, it was confirmed the TFO is liquefied and relatively well digested by the body. Saturated fatty acids ($C_{17}H_{34}O_2$) were present in 22.3% of TFO's, 22.79% of OFO's, and 19.5% of IFO's, respectively the approximate amount. The content of methyl stearate ($C_{19}H_{38}O_2$), a saturated fatty acid, was 33.65% the highest in inner fat oils (IFO), which indicates that the IFO is easily congealed.

3.3. Choosing the Mixing Ratio for Oils and Additions

Chemical parameters were determined by selecting soaps mixed in a ratio of 70:30, 80:20, and 90:10 based on the physical dilution of the mixture in different proportions. The chemical properties of liquid soap prepared with tail fat TFO and LO1 are shown in Figure 3.

According to the results of the chemical analysis, the most suitable soap was liquid soap in a ratio of 70:30. This is due to the fact that the soaps were evenly mixed, had a good appearance, high chemical properties, high foaming properties,

Table 2. Calculation of oils, substances for soap.

Raw oil's ratio	Volume of A1	Volume of A2	Total weight	pH	pH (after 24 h)
TFO 100%	5.27	9.9	45.17	12	9
LO1 100%	5.36	9.9	45.26	12	10
TFO: LO1 50%:50%	10.63	19.8	90.43	12	9
TFO: LO1 70%:30%	10.66	19.8	90.46	12	8
TFO: LO1 80%:20%	17.8	33	150.8	12	7
TFO: LO1 90%:10%	17.83	33	150.83	12	7

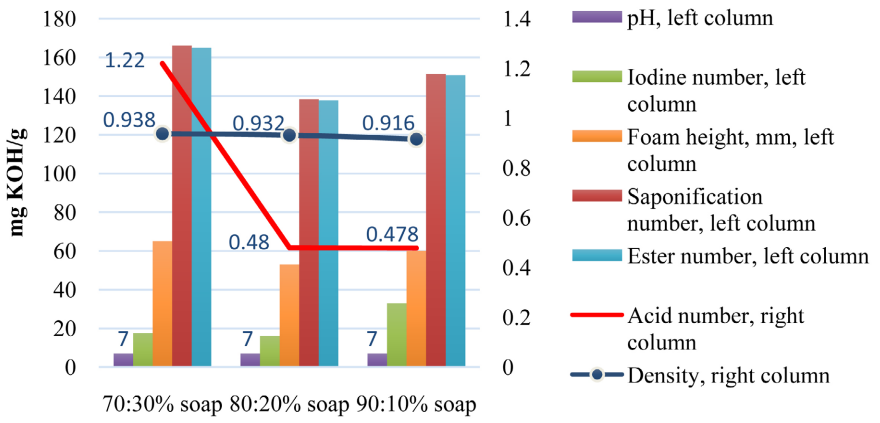

Figure 3. Chemical properties of the obtained liquid soap frm TFO and LO1.

Table 3. Some results of GC-MS analysis of fat oils.

Sample	Apex RT	Name	Formula	Area	Area, %
TFO	21.5	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	105,991,828	22.3
	23.86	9-Octadecenoic acid (Z)-, methyl ester	$C_{19}H_{36}O_2$	165,935,061	41.23
	23.99	Methyl stearate	$C_{19}H_{38}O_2$	108,710,556	22.87
	24.18	Octadecadienoic acid, methyl ester	$C_{19}H_{34}O_2$	12704371.39	2.67
OFO	21.49	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	135269202.1	22.79
	23.87	9-Octadecenoic acid (Z)-, methyl ester	$C_{19}H_{36}O_2$	216746451.6	33.31
	23.99	Methyl stearate	$C_{19}H_{38}O_2$	162124283.7	24.91
	24.26	9,12-Octadecadienoic acid, methyl ester	$C_{19}H_{34}O_2$	29214608.31	4.49
IFO	21.49	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	126786627.1	19.5
	23.85	9-Octadecenoic acid (Z)-, methyl ester	$C_{19}H_{36}O_2$	19570884.2	30.09
	23.97	Methyl stearate	$C_{19}H_{38}O_2$	218810958.3	33.65
	24.22	9,12-Octadecadienoic acid, methyl ester	$C_{19}H_{34}O_2$	20108367.09	3.09

good foaming, low acidity and pH neutral environment, which was higher than other soaps. It was also close to the soap standard.

3.4. Determine the Chemical Properties of the Obtained Liquid Soap from OFO and IFO

As mentioned earlier, OFO: LO1 and IFO: LO1 oils were mixed in a 70:30 ratio to make liquid soap, and the chemical properties were determined as shown in Table 4, Figure 4.

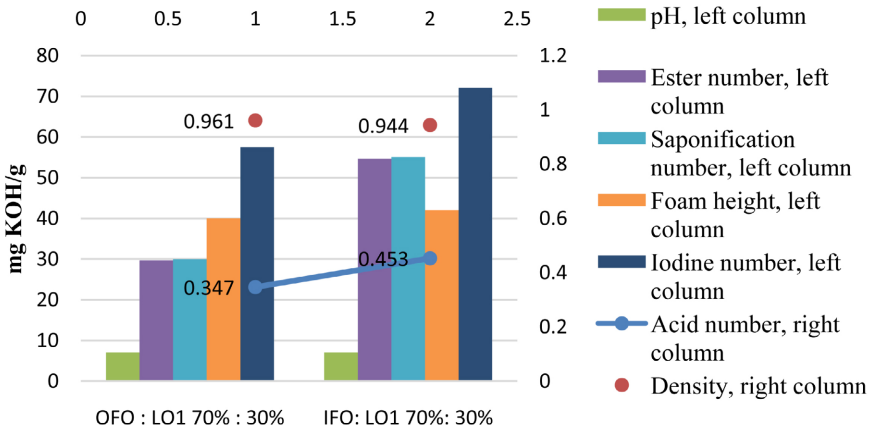

Figure 4. Results of experiments on liquid soaps obtained from OFO and IFO.

Table 4. Results of experiments on liquid soaps obtained from OFO and IFO.

Chemical properties	OFO: LO1 70%:30%	IFO: LO1 70%:30%
Acid number, mg KOH/g	0.347	0.453
Saponification number, mg KOH/g	30.012	55.078
Iodine number, %	57.51	72.05
Ester number, mg KOH/g	29.665	54.625
pH	7	7
Density, at 20˚C, kg/m^3	0.961	0.944
Foam height, ml	40	42

Low acidity in the determination of chemical parameters in soaps made of surface and inner fat indicates that the acidity is reduced when mixed with liquid oils, the main raw materials OFO and IFO. Low saponification and foaming indicate that OFO and IFO are not suitable for mixing with LO1.

3.5. Select the Appropriate Dilution Option

Soap made from sheep fat is not sufficiently liquid and has a high viscosity, so it needs to be diluted. The dilution was performed as follows.

Table 5 shows the dilution ratio of liquid soap and two substances. Dilute 10 ml of the diluted soap to 1%, 2% and 3% by weight of the soap. The diluted soap was tested after 24 hours. Chemical results of liquefied soap. The results of the chemical analysis of the dilute container after 24 hours are shown in Table 6.

Dilute 1 (D1): 1%, 2%, and 3% of the soap with D1 and D2 in a ratio of 70:30 to determine the technical characteristics of the prepared liquid soap and are shown in Table 6. After a total dilution of 6 different ratios, the analysis showed that the soap, which was diluted to 2% of D1, had a good appearance, saponification, foaming, a neutral pH, and low acid content. Therefore, the best option for diluting the soap was D1 2% dilution based on chemical characteristics and appearance.

3.6. Comparison of Diluted Soap and Undiluted Soap

1) The chemical properties of liquid soap were compared with that of undiluted soap.

The results in Table 7 show that dilute soaps were less acidic than undiluted soaps, and have better saponification, similar foaming, close density, less unsaturated fatty acids, and no color change.

2) In order to add fragrance, the essential oil was added to the selected soap and the product was checked for changes.

Table 8 shows that when essential oils are diluted in the soap in 5 different ratios of 1%, 2%, 3%, 4%, and 5%, soaps that are diluted in a ratio of 1% are highly

Table 5. Dilution ratio.

Samples	Liquid soap /70:30/
1% D1 /A/	10:1
2% D1 /A/	10:2
3% D1 /A/	10:3
1% D2 /Hy/	10:1
2% D2 /Hy/	10:2
3% D2 /Hy/	10:3

Table 6. Results of the chemical analysis in liquefied soap after dilution.

Sample	Foam height	Color	Acid number	Iodine number	pH	pH (24 hours)
1% diluted soap D1 /A/	45	Yellow	0.54	24.78	7	7
2% diluted soap D1 /A/	50	Yellow	0.72	19.41	8	7
3% diluted soap D1 /A/	45	Yellow	0.57	-	7	7
1% diluted soap D2 /Hy/	45	Yellow	0.88	29.05	9	7
2% diluted soap D2 /Hy/	45	Yellow	0.97	26.84	8	7
3% diluted soap D2 /Hy/	42	White	0.87	-	7	7

Table 7. Comparison of chemical properties of the diluted soaps.

Chemical properties	70:30 Undiluted soap	70:30 2% D1 /A/ diluted soap
Acid number	1.05	0.86
Saponification number	132.17	145.51
Ester number	131.12	144.65
Iodine number	25.38	19.67
Color	Yellow	Yellow
pH	7	7
Density,	0.961	0.976
Foam height	65	65

Table 8. Soap performance when essential oils are added.

Chemical properties	Soap + 1% essential oil
Acid number	0.467
Saponification number	40.036
Ester number	54.102
Iodine number	39.629
Color	0.976
pH	7
Foam height	65

dilute and odorless, in terms of color turned gray and had less foam. Therefore, taking into account the appearance, viscosity, odor and foaming, the essential oil was calculated as 1% of the total volume of the soap.

4. Conclusions

1) Research was conducted to make liquid soap by selecting the most common sheep tail fat (TFO), outer fat (OFO), and inner fat (IFO) in Mongolia. The content of fatty acids in these oils was determined by GC-MS analysis, and the tail fat oil (TFO) had the highest unsaturated fatty acid content. Chemical analysis also confirms the accuracy of the highest iodine number.

2) According to the results of the liquid soap prepared, the best alkali ratio is 10%, the amount of additive is 5% and the amount of essential oil is 1%. The liquid soap produced under these conditions met the standard requirements.

3) Sheep tail fat oil from Mongolian animal oil has been identified as a suitable raw material for making liquid soap. In terms of liquid soap production technology, the ratio of solid oil to liquid oil, which is the base preparation, was determined to be 70:30 and the dilution ratio was 10:1, respectively.

4) According to the results of the study, in the future, sheep's tail fat can be used to make a wide range of liquid and solid soaps, hand soaps, and cleansing lotions for human skin.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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