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Fractionation of Iranian Beef Tallow - Chemical and Physical Evaluations of the Fractions

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ABSTRACT: Large quantities of beef and mutton tallow are available in Iran every year. If these products are processed and formulated properly and scientifically, the need to import oils and fats in a substantial quantities might be reduced. The aim of this study is to fractionate beef tallow into different fractions and carry out physical and chemical tests on each isolated fraction. Beef fat was obtained from butchery shop in Tehran. The fat or tallow was obtained by dry rendering using a rotary evaporator. Fractionation took placed at 4°C for 22 hours. Physical and chemical tests concerning melting point, colour, free fatty acid concentration, refractive index, peroxide value, iodine value, induction period measurement and fatty acid composition were carried out on the original and fractionated samples. The results indicated yields of 94% and 98% for extraction and fractionation respectively. The statistical analysis of the samples indicated significant differences between the results obtained. The results also showed that the liquid fraction might be employed as salad or frying oil and the hard fraction might be used as a fraction in margarine or shortening fats.

Keywords: *Beef Tallow, Fractionation, Physical and Chemical Specifications.*

Introduction

The precise amount of beef or mutton tallow produced in Iran is not exactly known. Therefore the quantity of production is an estimate obtained from the slaughter houses in different cities and centers. Considering the quantities of beef, sheep and goats slaughtered every year to be consumed and/or used in various productions, a high quantity of fat could be obtained from their carcasses that might be economically and nutritionally important. Tallow is a saturated fat with a substantial quantities of saturated fatty acid namely palmitic and stearic acids and a high concentration of mono unsaturated fatty acid such as oleic acid. According to world statistics, 15.6 million tons of animal fats; lard and tallow were produced in 2005 (Ghasemi Afshar, 1385). Probably beef tallow was the first animal fat to be fractionated to produced fractions with lower and higher melting ranges by Hyppolyte Mege Mouries in 1869 (Gharachorloo, 1385; Rossel, 2001).

Luddy and his colleagues fractionated beef tallow and produced a liquid general purpose oil that was meant to be used as cooking or solid oil (Luddy *et al*., 1973). Taylor and his colleagues evaluated the fractionation of beef tallow economically and suggested that some fractions might be employed and can replace more expensive oils and fats (Bhattacharyya *et al*., 2000). Bussey and Ryan (1981) carried out a four stage fractionations of beef tallow with detergent and concluded that fractions obtained might be employed for different applications and formulations. Solvent

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fractionation was used by Unsal and Aktas in 2003 using acetone as solvent for a duration of 16 hours at 2, 17 and 37°C. Four fractions with the yields of 13.3, 28.8, 22.5 and 30.4 were obtained respectively. Further investigations by the mentioned researchers concerned with sheep tail end and its fractions were carried out in 2005. Similar work was carried out on sheep tail end and its different fractions that were isolated and could be used for different applications (Ghasemi Afshar, 1385).

The aim of this research work is to solvent fractionate beef tallow into different fractions and carry out series of physical and chemical tests on the isolated fractions.

Materials and Methods

Beef tallow was purchased from Tehran slaughter house, cleaned, washed, dried and cut into small pieces. 100 gr of dried fatty matter was placed in a rotary evaporator at 80°C and for 2 ½ hours under vacuum. The obtained fat (beef tallow) was mixed with acetone (9:1) and kept at 4°C for 22 hours and then filtered. Two fractions were isolated.

The original fat, the stearin and olein fractions were subjected to a series of chemical and physical tests. Percent free fatty acid was obtained by titration with a standard solution of alkali according to AOAC standard method, number 940.28 (Firestone, 1997). Peroxide value was determined by AOCS standard method, cd 8-53 (Firestone, 1997). Fatty acid composition and profile was determined by conversation of fatty acid into their methyl ester derivatives according to AOAC standard method, number 969.33 (Firestone, 1997) and then application of the prepared samples into a Agilent Acme 6100 gas chromatography apparatus equipped with Flame Ionization Detector and a cp sill 88 capillary column according to AOCS, cele-91 standard method (Firestone, 1994). Refractive index was determined by Kruss refractometer at 50°C according to AOAC method, number 921.08 (Firestone, 1997). Melting point was obtained according to AOCS method, C22-38 (Firestone, 1997). Colour measurement was carried out by Lovibond Tintometer apparatus in 1 inch cell according to AOCS standard method, Cc13e-92 (Firestone, 1997). Induction period was measured by Metrohm Rancimat model 743, using 2.5 g of the sample at 110°C with an air current flow of 18-20 lit/h according to AOCS standard method. Iodine number, measuring the unsaturation of oil was calculated according to AOCS standard method, cd1c-85 based on fatty acid composition (Firestone, 1997).

Statistical analysis were carried out according to the statistical analysis system software package on replicated tests. Analyses of varriance were performed by the application of ANOVA procedure. Significant differences between means were determined using Duncan multiple range test.

Results and Discussion

Tables 1 and 2 present the fatty acid composition and physical and chemical properties of beef tallow, tallow stearin and tallow olein fractions respectively. The separated fat that was isolated from the fatty matter with the average yield of 94% was obtained at low rendering temperature and had a mild aroma and colour appearance.

Table 1. Fatty acid composition of the samples

Sample/ Fatty Acid Composition [%]	C14 : 0	C16 : 0	C18 : 0	C18 : 1	C18 : 2	C18 : 3
Tallow	3.70	21.50	17.70	41.40	3.51	0.60
Tallow olein	3.66	19.25	13.55	45.35	4.60	0.85
Tallow stearin	4.32	27.60	19.10	33.70	2.40	0.33

Table 2. Physical and chemical properties of samples

Factor	Tallow	Tallow olein	Tallow stearin
Free fatty acid (%)	0.98	1.02	1.00
Peroxide value (meq/kg)	0.00	0.00	0.00
Induction period (h)	7.90	2.26	9.97
Melting point (˚C)	36.80	18.15	45.90
Refractive index at 50˚C	1.4556	1.4590	1.4540
Iodine value	60.70	89.25	39.45
Yellow (Loviband unit)	1.00	1.60	0.70
Red (Loviband unit)	0.90	1.80	0.70

Rendering at low temperature under vacuum removed some of the unwanted impurities. Fractionation at 4°C for 22 hours provided two fractions with a total yield of 98%. Ghasemi afshar (1385) in three stage fractionations carried out at 25, 15 and 5°C had 97.6% recovery that is similar to the present work.

The amounts of free fatty acids in the original and fractionated samples are low, that means the enzymatic activities are minimum and the concentration of free fatty acid is lower than the figure defined by codex standard (1.25%).

The peroxide values of the original and fractionated tallow indicated minimum oxidative rancidity that is due to the high concentrations of saturated and mono unsaturated fatty acids present and the fact that the fat was extracted by low heat treatment under the vacuum.

Figures 1, 2 and 3 and Table 1 show the fatty acid profiles and composition of beef tallow and its fractions.

Tallow olein with a high concentration of mono unsaturated fatty acids namely oleic acid with a moderate range of melting behavior might be considered a low melting fat while the stearin fraction with a high content of saturated fatty acids such as palmitic and stearic acids might be employed for certain food formulations and practices particularly for pastry and confectionary products where the high melting fat is required to keep the structure and texture of the final product to a certain point. Both fractions might be also used in some products such as margarine where a wide plasticity is required. The hard fraction might also be required as a fraction in the interesterification process. The soft fraction or olein fraction can be subjected to further fractionation at lower temperatures to receive lower melting oils that might be used for salad, cooking and frying practices. The stabilities of the original and fractionated tallow at 110ºC are reasonable considering that animal fats namely tallow and lard are deficient in natural antioxidants such as tocopherols. The addition of minute amount of vegetable oils to these fractions could improve their stability.

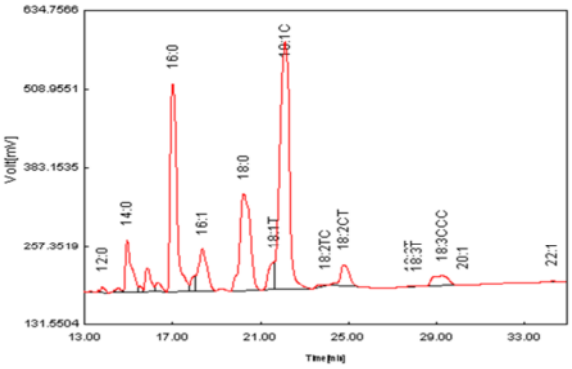

Fig. 1. Fatty acid profile of tallow

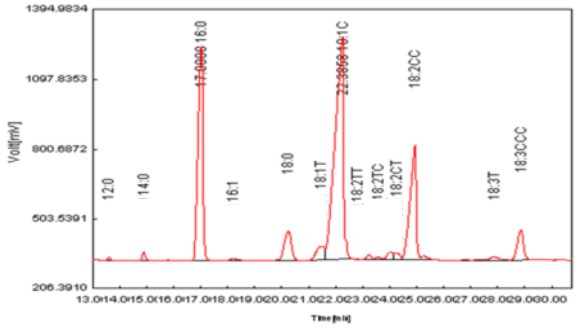

Fig. 2. Fatty acid profile of tallow stearin

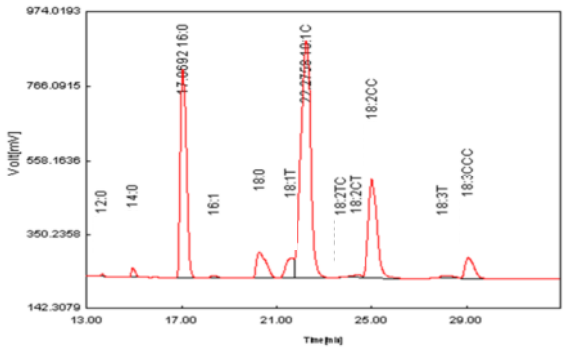

Fig. 3. Fatty acid profile of tallow Olein

Conclusion

Beef tallow was fractionated into two fractions at 4°C. the fractions might be considered ideal for confectionary and pastry products or be used as a fraction in some processes namely interesterification practice. Liquid or salad oil might be obtained by further fractionation of tallow olein at lower temperatures. Odors and tastes of the products might create some problems due to unacceptability by consumers, but these unwanted impurities can be removed by specific deodorization procedure.

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