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Composition of ghee (Samn Barri's) from cow's and sheep's milk

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The physical and chemical characteristics of ghee extracted from cow's and sheep's milk were studied. Iodine number was lower, but saponification number was higher in sheep's ghee. 1,2-Diacylglycerides were absent in sheep ghee. The range of vitamin A was 315–376 μg/100 g and of cholesterol 252–284 mg/100 g. Fatty acid composition showed a relatively high degree of saturation (53·9–66·8%) with C16 : 0 (31·7–38·3%) and C18 : 1 (21·6–33·7) being the predominant saturated and unsaturated fatty acids, respectively.

INTRODUCTION

Ghee or clarified butter is a widely consumed food commodity in Saudi Arabia. It is usually made by farmers in villages and bedouins in the desert from sheep and cows during seasons when milk is in great abundance. Most of the ghee products available in the market are traditionally produced by manual churning of naturally fermented milk and heating of the resulting butter to obtain the ghee. Literature related to the quality of such products is still lacking. Sawaya *et al.* (1984) studied the physical and chemical characteristics of ghee from goat's and sheep's milk. However, the locally produced cow's ghee, which is the most popular ghee product in Saudi Arabia, has not yet been investigated; therefore the objectives of this study were to carry out such an investigation of three commonly consumed ghee products from different sources, two different cow breeds (Frezeno, Zibu) and a sheep breed (Najdi).

MATERIALS AND METHODS

Preparation of samples

Cow butter was separated from Frezeno cow milk from the Animal Production Department, College of Agriculture, King Saud University and from a local breed called Zibu raised on a farm partially on pasture in the Al-Qasem area, Saudi Arabia. The sheep butter was obtained from the milk of the most popular sheep breed (Najdi) which was on pasture in the same area.

Ghee samples were prepared in the traditional manner practised in Saudi Arabia (Sawaya *et al.*, 1984). The only deviation from this procedure was the use of an electrical instead of a manual churner.

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Chemical analysis

Chemical analyses of ghee included specific gravity, refractive index, acid value, peroxide value, iodine number, saponification number and insolubility, determined according to the method of IUPAC (1979). Separation of the lipid components present in ghee samples was achieved by thin-layer chromatography (TLC) with hexane/diethyl ether/acetic acid (80 : 20 : 1 (v/v/v)) as developing solvent (Smith *et al.*, 1977).

Vitamin A and cholesterol

The HPLC instrumentation consisted of a Waters Model 410 solvent delivery system (Waters Associates, Milford, MA, USA), a Waters U6K injector system, a Waters 481 Spectrophotometer detector, auto control set at 325 nm and Waters 820 Maxima software for data handling. A 30 cm × 4 mm column containing 10 μm Bondapak C18 (Waters Associates) was used in this study.

The chromatographic mobile phase consisted of a mixture of HPLC grade acetonitrile (ACN), dichloromethane (DCM) and methanol (MeOH). All solvents were filtered through a 0·45 μm cellulose membrane filter (Waters, Millipore). Samples were extracted according to the procedure of Mills (1985) and Al-Abdullaly & Simpson (1989). They were dissolved in 5 ml of chromatographic solvent (ACN : DCM : MeOH, 70 : 20 : 10 (v/v/v)) and filtered through a 0·45 μm membrane filter (Waters, Millipore). The concentration of vitamin A in the sample was determined by HPLC set at a detector wavelength of 325 nm. The standard used was retinol (Sigma Chemical Co., St. Louis, MO, USA)

which had been purified several times by recrystallization, dissolved in the chromatographic solvent system (Nelis & Deleenheer, 1983).

Peak identification was based on retention time and co-chromatography with standard. Peak areas were measured and a standard curve was prepared which was linear for vitamin A over the range of 50–300 μg injected. For cholesterol determination, samples had first been prepared by the procedure of AOAC (1984) and colorimetrically determined by the assay of Rotenberg & Christensen (1976).

Fatty acid composition

The fatty acid compositions of ghee samples were determined by gas chromatography (GC) according to the procedure described by Metcalfe *et al.* (1966). Fatty acid methyl esters were identified on a Shimadzu gas chromatograph (GC-16A) with flame ionization detector at 260°C. The hydrogen, air and nitrogen flow rates were 50,450 and 60 ml/min, respectively. A 1-μl sample was injected on a 300 cm × 3 mm column packed with diethylene glycol succinate (DEGS). The injection temperature was 250°C and the column temperature was 190°C. Comparison between the peaks of the samples and those of the standards, run on the same column under the same conditions, was used for identification.

RESULTS AND DISCUSSION

Table 1 shows the physicochemical characteristics of ghee. The data generally indicate minor differences between ghee samples. Iodine number was lower in sheep's ghee compared with cow's ghee. Values of the iodine number (25·5–36·8) indicate that ghee is not highly unsaturated. However, saponification number, which is the measure of the average molecular weights of the glycerides, was higher in sheep's ghee. Cow's ghee (Frezeno) was the highest in free fatty acids (Table 1). Sawaya *et al.* (1984) reported 1·4591, 28·4,207 and 1·99 for refractive index, iodine number, saponification number and acid value, respectively, in sheep (Najdi) ghee. Factors such as milk quality, method of preparation, clarification temperature, storage conditions and type of animal feed can determine the physicochemical characteristics of ghee (Ganguli & Jain, 1972).

Table 1. Physicochemical characteristics of cow's and sheep's ghee and their contents of vitamin A and cholesterol

Analysis	Cow breed		Sheep
	Zibu	Frezeno	
Refractive index (30°C)	1·46	1·46	1·46
Specific gravity (60°C)	0·89	0·89	0·89
Solubility	23·00	24·00	27·00
Acid value (%FFA)	0·48	0·90	0·65
Iodine number	35·30	36·80	25·50
Saponification number	227	228	235
Peroxide value (meg/kg)	0·21	1·67	1·49
Vitamin A (μg/100 g)	337	315	376
Cholesterol (mg/100 g)	252	284	265

Table 2. Fatty acid composition of cow's and sheep's ghee (%)

Analysis	Cow breed		Sheep (Najdi)
	Zibu	Frezeno	
12 : 0	2·98	2·92	4·17
14 : 0	12·2	9·34	12·6
16 : 0	38·3	31·7	38·1
18 : 0	9·57	9·94	11·9
18 : 1	31·8	33·7	21·6
18 : 2	1·40	4·30	1·23
Others	3·5	8·0	10·4
SFA	63·1	53·9	66·8
UFA	33·2	38·0	22·8
P/S[a]	0·53	0·70	0·34

[a] *P/S* = sum of all polyunsaturated/sum of all saturated fatty acids. SFA = Saturated fatty acids; UFA = unsaturated fatty acids.

Thin-layer chromatography (TLC) shows the absence of 1,2-diacylglycerides (C) in sheep's ghee (Fig. 1). Visually, the staining of cholesterol esters (G) and triacylglycerides (F) was more intense in cow's ghee (Frezeno and Zibu).

Data on vitamin A are shown in Table 1. Vitamin A contents are 337, 315 and 376 μg retinol/100 g for cow (Zibu, Frezeno) and sheep, respectively. Musaiger and Aldallal (1985) reported 420 μg/100 g for retinol in cow's ghee. Such variations in retinol contents might be due to a number of factors, including breed of the animal, feed and time of the year (Webb *et al.*, 1980). In this study, ghee from animals (Zibu cow, sheep) on pasture showed higher retinol and this was expected as carotenes are normally higher in the pasture than in the feed lot.

Table 1 shows the cholesterol contents of different ghee samples. The values range from 252 to 284 mg/

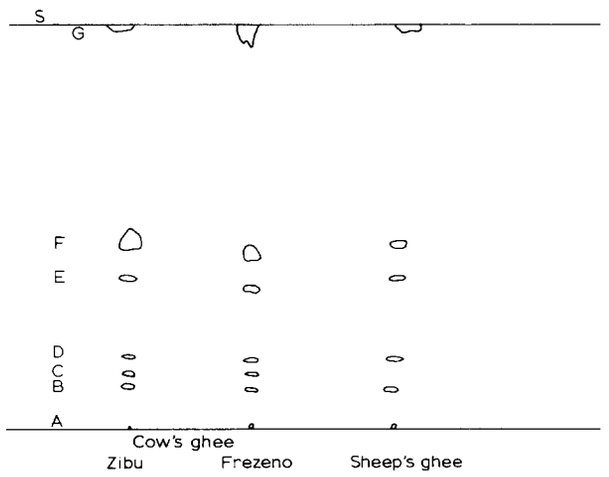

Fig. 1. Thin-layer chromatography of lipid composition of cow (Zibu, Frezeno) and sheep ghee. Letters denote lipid class as identified by standards. A: Complex lipids; B: monoglycerides; C: 1,2-diacylglycerides; D: 1,3-diacylglycerides; E: free fatty acids; F: triacylglycerides; G: cholesterol esters; S: solvent front. Compounds were visualized by a 10% sulfuric acid spray.

100 g, whereas Musaiger and Aldallal (1985) reported 230 mg/100 g for cholesterol in butter.

Fatty acid profiles of all ghee samples were identical (Table 2). Palmitic and oleic acids were the main fatty acids and this is in agreement with the findings of Sawaya (1984), who reported 3·9, 11·3, 30·3, 8·0, 21·5 and 2·4 for C12 : 0, C14 : 0, C16 : 0, C18 : 0, C18 : 1 and C18 : 2, respectively, in sheep's (Najdi) ghee. The lowest oleic and the highest linoleic levels were found in sheep's and cow's (Frezeno) ghee, respectively. The *P/S* ratio was obtained by dividing the total polyunsaturated fatty acids (PUFA) by the total saturated fatty acids, regardless of chain length. Cow's ghee (Frezeno) had the highest *P/S* ratio (0·7) while the lowest *P/S* ratio was for sheep's ghee (0·34). The *P/S* ratio is of importance with regard to the lipid intake–health relationships.

The findings of this study and those of Sawaya *et al.* (1984) can provide local consumers with some nutritional information on locally produced ghee, which is consumed daily, and to help the Saudi Arabian Standards Organization (SASO) establish some local specifications or gradings of ghee products.

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