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Technical Note

Physical and Chemical Characteristics of Ghee and Butter from Goat's and Sheep's Milk

ABSTRACT

The physical and chemical characteristics of the butter and ghee of goat's and sheep's milk were studied. The saponification numbers of both butter and ghee samples prepared from goat's and sheep's milk were slightly high but showed low iodine and Reichert–Meissl values. Fatty acid composition revealed a relatively high degree of saturation (63·6–74·1%) with $C_{16:0}$ (27·6–30·5%) and $C_{18:1}$ (19·6–30·1%) being the predominant saturated and unsaturated fatty acids, respectively. The effect of heat on butter during its processing into ghee was minimal with no major differences being observed in the chemical and physical characteristics of either butter or ghee samples prepared from it.

INTRODUCTION

Ghee ('Samn Barri'), or clarified butter, made mainly from sheep's milk, but sometimes from goat's milk, is traditionally a highly consumed food commodity in various parts of the Middle East. In Saudi Arabia, milk production from sheep and goats amounted to about 300,000 tons in 1980 (Anon., 1981). However, the major bulk of the milk is usually consumed by the herdsmen during seasons of low production and the only dairy products that reach the consumer or are commercially available are ghee and 'Madeer' (a dried, cheese-like product) which are usually prepared during the season when milk is in great abundance. There are no standard

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procedures for the preparation of ghee as such; however, all the ghee locally available is produced by the pastoral population employing the traditional method of manually churning the naturally fermented milk and heating the butter to obtain ghee. Information is still lacking in the literature on the chemical properties of the sheep and/or goat ghee utilized in the Middle East, particularly in Saudi Arabia. The objective of the investigation reported in this paper was to study the chemical characteristics and fatty acid composition of butter from two major and popular sheep breeds, Najdi and Nuaimi (Awasi), and one goat breed, Aardi, from Saudi Arabia and the ghees prepared from it in the traditional manner of the pastoral population of Saudi Arabia.

MATERIALS AND METHODS

Preparation of samples

Samples were prepared in the traditional manner practised at a desert location in the Eastern province of Saudi Arabia, 100 km southwest of Dammam. Fresh samples of both sheep's (Najdi and Nuaimi) and goat's (Aardi) milk were collected in 6 × 10-liter containers. The containers were covered with cheese cloth and left in the sun for about 4 h, thus initiating a natural fermentation process. The milk samples were then taken out of the sunlight, covered with cloths and kept in a warm place (30 °C) for 3–4 h until sour. The butter samples were obtained by churning sour milk in a manual churner for about 2 h. Ghee was prepared by gently heating the butter obtained in an open container for 15–20 min. After boiling for a few minutes, a little wheat flour was added and mixed with the ghee to absorb any water left in the sample. Salt was also added for flavoring purposes and a small piece of onion for the absorption of any undesirable odours. The ghee was then filtered through several layers of cheese cloth into a glass jar and kept under refrigeration for further analysis.

Physical and chemical analyses

Chemical analyses for acid value, iodine number, saponification value, Hehner value, Reichert–Meissl number and unsaponifiable matter were determined according to the methods of the AOAC (1980). Refractive index was determined by an Abbe refractometer with temperature adjustment (American Optical, Model 10450).

Fatty acid analysis

Fatty acids were determined in the samples as their methyl esters by gas–liquid chromatography. The methyl esters were prepared according to procedures outlined by the AOCS (1974). Fatty acid methyl esters of $C_{12:0}$–$C_{20:4}$ chain length were analyzed by means of a gas–liquid chromatograph (HP 5370A) equipped with a flame ionization detector using a 2 mm inside diameter × 2·5 m glass column packed with 10% SP 2300 on 80/100 Supelcoport. Column temperature was 120–220 °C at 4 °C/min. The flow rates of N_2 (carrier gas), hydrogen and air were 40, 40 and 200 ml/min, respectively. Fatty acid methyl esters of $C_{6:0}$–$C_{10:0}$ chain lengths were analyzed as above except that the column temperature was 85–220 °C at 4 °C/min. The butyric ethyl ester was analyzed using a 4 mm inside diameter × 2·0 m glass column packed with 10% SP 1200 with 1% phosphoric acid on 80/100 Chromosorb WAW. The column temperature employed was 80–190 °C at 4 °C/min. Identification of the different peaks was done by comparing their retention times with those of authentic standards and peak areas were integrated by a computing integrator. Fatty acid profiles were quantitated according to the methods of the AOCS (1977).

RESULTS AND DISCUSSION

Samples of butter made from both goat's and sheep's milk (Table 1) had relatively close iodine values, Reichert–Meissl and saponification numbers compared with those of cow's butterfat (Meyer, 1969). The acid values were slightly higher while those of the unsaponifiable matter were within the range for cow's milk (Swern, 1979). Only minor differences were observed in the different physical and chemical characteristics of the butter samples prepared from both goat's and sheep's milk, as well as the corresponding ghee samples (Table 1).

Even though heat did not have a major effect on the characteristics evaluated, the levels of the free fatty acids in ghee were increased approximately twofold relative to their levels in the corresponding butterfat samples. These results are in agreement with those reported by other investigators (Fritsch *et al.*, 1979; Du Plessis, 1981). Moreover, the unsaponifiable matter contents were also slightly higher in the ghee samples.

TABLE 1
Physical and Chemical Characteristics of Sheep and Goat Butter and Ghee

	Goat breed		*Sheep breed*			
	Aardi		*Nuaimi*		*Najdi*	
	Butter	*Ghee*	*Butter*	*Ghee*	*Butter*	*Ghee*
Refractive index	1·4568	1·4600	1·4602	1·4602	1·4559	1·4591
Iodine number, Wijis	24·0	31·9	23·2	31·8	21·3	28·4
Saponification number	240	239	232	228	217	207
Hehner value	79·6	89·5	77·2	89·0	79·0	91·8
Acid value	1·16	3·26	1·05	1·82	0·96	1·99
Unsaponifiable matter	0·75	1·09	0·96	1·40	0·69	1·34
Reichert–Meissl value	20·0	19·3	22·6	22·7	24·2	23·8

TABLE 2
Fatty Acid Composition of Goat and Sheep Butter and Ghee (g/100 g)

Fatty acid	*Goat breed*		*Sheep breed*			
	Aardi		*Nuaimi*		*Najdi*	
	Butter	*Ghee*	*Butter*	*Ghee*	*Butter*	*Ghee*
$C_{4:0}$	3·0	2·2	3·5	3·5	2·3	3·7
$C_{6:0}$	2·0	1·7	1·6	1·9	4·4	3·6
$C_{8:0}$	2·0	1·8	1·7	1·8	1·9	1·9
$C_{10:0}$	6·1	5·7	5·0	5·3	6·8	5·8
$C_{12:0}$	2·9	2·6	3·2	3·2	4·7	3·9
$C_{14:0}$	9·5	8·4	9·7	9·3	11·8	11·3
$C_{14:1}$	0·4	0·3	0·5	0·4	0·5	0·6
$C_{15:0}$	0·9	0·7	1·2	0·9	1·8	1·6
C_{15-1}	0·2	0·2	0·3	0·2	0·3	0·3
$C_{16:0}$	28·6	27·6	28·6	28·2	30·5	30·3
$C_{16:1}$	2·5	2·1	2·4	2·3	2·0	2·3
$C_{17:0}$	1·0	1·0	1·3	1·2	1·0	1·1
$C_{17:1}$	0·6	0·6	0·8	0·8	0·6	0·7
$C_{18:0}$	10·3	11·4	10·2	10·5	8·4	8·0
$C_{18:1}$	26·3	30·1	26·1	26·7	19·6	21·5
$C_{18:2}$	2·6	2·5	2·6	2·6	2·2	2·4
$C_{18:3}$	0·3	0·2	0·2	0·2	0·2	0·2
$C_{20:0}$	0·6	0·5	0·6	0·6	0·5	0·5
$C_{20:1}$	0·2	0·2	0·2	0·2	0·2	0·1
$C_{20:2}$	0·1	<0·1	<0·1	<0·1	<0·1	<0·1
$C_{20:3}$	0·2	0·2	0·3	0·3	0·3	0·3
$C_{20:4}$	<0·01	<0·01	<0·01	<0·01	<0·01	<0·01

Fatty acid composition

The fatty acid composition of both goat and sheep butter samples (Table 2) showed a relatively high content of the short chain fatty acids, $C_{4:0}$–$C_{10:0}$ (11·4–15·4%), compared with that of cow's fat. Caproic acid was the major short chain fatty acid present in both goat and sheep butter. The degree of saturation ranged between 63·6% in goat, and 74·1% in Najdi sheep, butter, the latter being relatively higher than that of cow's milk (Anon., 1961). Of the saturated fatty acids, palmitic was predominant in both goat and sheep butter, while oleic was the major unsaturated fatty acid. The oleic acid level was lowest (19·6%) in the Najdi sheep butter and highest (30·1%) in goat butter. Linoleic and arachidonic acids both represented less than 3% in all butter samples investigated.

There was no major effect of heat during processing under the present conditions—which are considered to be relatively mild—on the fatty acid patterns of either goat or sheep ghee samples. These results are in agreement with those of Du Plessis (1981) who found that there was no major change in the fatty acid profiles of frying oils due to frying when oils were extracted from chips at 2, 50 and 98 h of frying.

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