EFFECT OF LACTATION NUMBER ON THE POLY-UNSATURATED FATTY ACIDS AND OXIDATIVE STABILITY OF MILK FATS

DARSHAN LAL and K.M. NARAYANAN

National Dairy Research Institute, Karnal-132 001

(Received: October 12, 1983)

INTRODUCTION

The oxidative stability of milk fat is known to be influenced by its unsaturated fatty acid content and glyceride composition (Rama Murthy and Narayanan, 1974; Agarwal and Narayanan, 1979). There is no report available on the effect of lactation number (age) of the animal on the poly-unsaturated fatty acid (PUFA) contents and oxidative stability of buffalo and cow milk fats. An attempt was, therefore, made to study this aspect and the results are presented here.

MATERIALS AND METHODS

Samples of buffalo and cow milk were collected from the three lactation groups such as (1) 1 to 3 lactations, (2) 4 to 6 lactations, and (3) 7 and above lactations (Darshan Lal and Narayanan, 1982) and their milk fats were prepared (Darshan Lal and Narayanan, 1983). The PUFA contents of these fats were determined by the alkali isomerization method of Herb and Riemenschneider (1953) as adopted by AOCS (1962), using Carl-Zeiss spectrophotometer. For evaluating the oxidative stability of milk fats, storage studies were carried out both at 80°C and 37°C. All storage studies at 80°C were conducted by storing the samples in 125 ml glass bottles with air tight stoppers, in an incubator maintained at 37°C ± 0.5°C. During the storage period, all samples were analysed, at regular intervals for peroxide value by Lea's method as described in IS-3508 (ISI, 1966).

RESULTS AND DISCUSSION

Poly-unsaturated fatty acids: The Poly-unsaturated fatty acid (PUFA) contents of cow and buffalo milk fats of the three lactation groups are shown in Table 1. In all the milk fats, conjugated and non-conjugated forms of dienoic, trienoic, tetraenoic and pentaenoic acids were detected and estimated. All the milk fat samples used for the study were also analysed for phospholipid contents and they were found to contain only traces of phospholipids (3.5 mg/100 g).

The average total poly-unsaturated fatty acid contents of milk fats from 1st, 2nd and 3rd lactation groups of buffaloes were 1.9731, 1.8597 and 2.1293%, respectively. The corresponding values of cow milk fats were 2.2559, 2.0786 and 2.3976%. This showed that in both buffalo and cow milk fats the average total PUFA content decreased from 1st lactation group to 2nd lactation group, and thereafter it increased from 2nd lactation group to 3rd lactation group. Of the total PUFA, the non-conjugated fatty acids constituted more than the conjugated forms in both buffalo and cow milk fats from all the lactation groups. The total non-conjugated fatty acids in 1st, 2nd and 3rd lactation
<table>
<thead>
<tr>
<th>Poly-unsaturated fatty acid</th>
<th>Lactation groups*</th>
<th>Lactation groups*</th>
<th>Lactation groups*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1 to 3 lactations)</td>
<td>(4 to lactations)</td>
<td>(7 and above lactations)</td>
</tr>
<tr>
<td></td>
<td>Buffalo milk fat</td>
<td>Cow milk fat</td>
<td></td>
</tr>
<tr>
<td>Dieneic %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conjugated</td>
<td>0.7477±0.0157</td>
<td>0.7476±0.0126</td>
<td>0.9166±0.0382</td>
</tr>
<tr>
<td>Non-conjugated</td>
<td>0.6422±0.0257</td>
<td>0.5116±0.0303</td>
<td>0.5798±0.0497</td>
</tr>
<tr>
<td>Total</td>
<td>1.3899±0.0382</td>
<td>1.2592±0.0395</td>
<td>1.4965±0.0116</td>
</tr>
<tr>
<td>Trieneic %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conjugated</td>
<td>0.0114±0.0005</td>
<td>0.0117±0.0005</td>
<td>0.0129±0.0003</td>
</tr>
<tr>
<td>Non-conjugated</td>
<td>0.3679±0.0090</td>
<td>0.4066±0.0050</td>
<td>0.4121±0.0188</td>
</tr>
<tr>
<td>Total</td>
<td>0.3793±0.0086</td>
<td>0.4177±0.0045</td>
<td>0.4250±0.0185</td>
</tr>
<tr>
<td>Tetraeneic %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conjugated</td>
<td>0.0051±0.0001</td>
<td>0.0055±0.0001</td>
<td>0.0055±0.0000</td>
</tr>
<tr>
<td>Non-conjugated</td>
<td>0.1087±0.0050</td>
<td>0.1032±0.0035</td>
<td>0.1109±0.0043</td>
</tr>
<tr>
<td>Total</td>
<td>0.1138±0.0051</td>
<td>0.1087±0.0035</td>
<td>0.1164±0.0042</td>
</tr>
<tr>
<td>Pentaeneic %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conjugated</td>
<td>0.0041±0.0000</td>
<td>0.0020±0.0001</td>
<td>0.0017±0.0001</td>
</tr>
<tr>
<td>Non-conjugated</td>
<td>0.0887±0.0049</td>
<td>0.0720±0.0144</td>
<td>0.0898±0.0038</td>
</tr>
<tr>
<td>Total</td>
<td>0.0901±0.0049</td>
<td>0.0740±0.0144</td>
<td>0.0915±0.0039</td>
</tr>
</tbody>
</table>

* Average of three trials.
Effect of Lactation Number

Among the PUFA of both buffalo and cow milk fats, the dienoic acids constituted the maximum, followed by trienoic, tetraenoic and pentaenoic acids. In buffalo milk fats, the dienoic, trienoic, tetraenoic and pentaenoic acids constituted 70.44, 19.22, 5.77 and 4.57% in 1st lactation group; 67.71 22.46, 5.85 and 3.98% in 2nd lactation group, and 70.28, 19.95, 5.47 and 4.30% in 3rd lactation group, respectively. The corresponding values in cow milk fats were 74.46, 17.54, 4.55 and 3.45% in 1st lactation group; 74.14, 17.51, 4.95 and 3.40% in 2nd lactation group, and 73.67, 18.13, 4.76 and 3.44% in 3rd lactation group, respectively.

In milk fats of both the species, the bulk of trienoic, tetraenoic and pentaenoic acids were in the non-conjugated form, but of dienoic, conjugated form was the maximum. The dienoic trienoic, tetraenoic and pentaenoic acids slightly decreased from 1st lactation group to 2nd lactation group and then increased from 2nd lactation group to 3rd lactation group in both buffaloes and cows milk fats, except the trienoic acid in buffalo milk fats. In each lactation group, the average total tetraenoic and pentaenoic acids were slightly more in buffalo milk fat than in cow milk fat.

The general trends in the distribution of the conjugated and non-conjugated PUFA, except dienoic, in the present study are in agreement with those reported for cow (Smith and Jack, 1954; Smith, 1961; Boatman et al., 1965; Rama Murthy and Narayanan, 1972; Agarwal and Narayanan, 1977) and buffalo (Rama Murthy and Narayanan, 1972) milk fats. In the case of dienoic acid, these authors observed a slightly lower content of conjugated acid than its non-conjugated type. However Stadhouders and Mulder (1955) in cow milk fat and Arumughan and Narayanan (1979) in both cow and buffalo milk fats have observed a higher conjugated dienoic acid content than its non-conjugated form as observed in the present study.

The poly-unsaturated fatty acids present in the animal diet are subjected to profound changes in the rumen by the microflora (Katz and Keeney, 1966, 1967). Most of the 18:2 and 18:3 fatty acids in the diet are converted to 18:0 acid by biohydrogenation. However the PUFA present in milk fat are derived from the constitutional lipids of rumen protozoa and those which escape hydrogenation in the rumen. As the milk samples for this study were collected from buffalo and cow under identical conditions, the slight differences observed between the PUFA contents of buffalo and cow milk fat could be due to the differential biochemical activities in the rumen and mammary gland of these two species.

Oxidative stability of milk fat: The effects of the three lactation group on the oxidative stability of buffalo and cow milk fats are shown in Tables 2 and 3.

Table 2 shows the development of peroxides during storage at 80°C and 37°C of buffalo and cow milk fats from three lactation groups. From this, it is seen that as the period of storage increased, there was a progressive increase in the development of peroxides in all the three lactation groups. The peroxide development in both buffalo and cow milk fats slightly decreased from the 1st lactation group to the 2nd lactation group, and then increased from the 2nd lactation group to the 3rd lactation group.

In both of the storage temperatures studied,
a comparison of the data on buffalo and cow milk fats showed that the development of peroxides was faster in buffalo milk fat than in cow milk fat in the three lactation groups studied. Similar differences in the development of peroxides in milk fats of the two species have also been reported earlier (El-Sokkary and Gho­neim, 1951 ; Narayanan et al., 1953, 1954; Vachha et al., 1957; Narayanan and Anantakrishnan, 1959, 1960; Rama Murthy et al., 1968, 1969).

The lower oxidative stability shown by buffalo milk fat as compared to that of cow milk fat may be attributed to the differences in the composition of these two types of fats, especially with regard to their lower contents of tocopherol, absence of carotene (Narayanan et al., 1956) and slightly higher amounts of tetraenoic and pentaenoic fatty acids (Rama Murthy and Narayanan, 1972). Tocopherols are reported to have antioxidant properties in fats (Swift et al., 1942; Bector and Narayanan, 1972). β-carotene is also reported to play a role as antioxidant in fats (Vachha et al., 1957). However, it has been reported by buffalo milk fat with β-carotene did not improve its oxidative stability. The poly-unsaturated fatty acids have been known to play an important role in the oxidation of milk fat. The rate of oxidation of unsaturated fatty acids was also known to increase with increasing number of double bonds (Silbert, 1962; Holman, 1966; Slawson and Stein 1970).

The slight differences observed in the
oxidative stability of cow and buffalo milk fats in three lactation groups may be attributed to their differences in the fatty acid composition (Darshan Lal and Narayanan, 1983).

From the above studies it can be concluded that the lactation number has slight effect on the poly-unsaturated fatty acids and oxidative stability of milk fats.

SUMMARY

The average content of dienoic, tetraenoic and pentaenoic acids of buffalo and cow milk fats slightly decreased from 1st lactation group (1-3 lactations) to 2nd lactation group (4-6 lactations) and then increased from 2nd lactation group to 3rd lactation group (7 and above lactations). During storage of these fats, the development of peroxides was found to decrease from the 1st lactation group to the 2nd lactation group and then there was an increase from the 2nd lactation group to the 3rd lactation group.

REFERENCES


Swift, C.E., Rose, W.G. and Jamieson, G.S. (1942) Oil and Soap 19, 176.