Canadian Nutrition Congress

Building Bridges in the Nutrition Research Community

Canadian Nutrition Congress
Winnipeg, Manitoba
2007
CAOCS CSAS CSNS

Destination Winnipeg/grajewski fotograph inc.

Winnipeg Convention Centre
June 18–21, 2007

Program & Proceedings

A Joint Meeting of

Canadian Section of the American Oil Chemists' Society
Canadian Society for Nutritional Sciences
Canadian Society of Animal Science

University of Manitoba · Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada · Canada · Nestlé Nutrition

Contents

Plenary Symposium Speakers

Invited Speakers

Graduate Student Competition Abstracts

CNC Poster Session Abstracts – Series 100

CNC Poster Session Abstracts – Series 200

CNC Poster Session Abstracts – Series 300

CNC Poster Session Abstracts – Series 400

CNC Poster Session Abstracts – Series 500

CNC Poster Session Abstracts – Series 600

CNC Poster Session Abstracts – Series 700

Canadian Workshop on Conjugated Linoleic Acid (CLA)

to findings where chronic administration of antimanic drugs to rats decreases turnover of arachidonic acid in brain phospholipids, suggest that excessive NMDA signaling via arachidonic acid may be a contributing factor to the manic phase of bipolar disorder. The results suggest that chronic NMDA-treated animals may be a model of upregulated arachidonic acid turnover in bipolar disorder.

CNC_527

Total alkyl and alkenyl ether composition of meat from beef fed pasture or concentrate or retail meats.

Mayer, F.[1], Kramer, J.K.G.[2], Nürnberg, K.[3] and Steinhart, H.[1]*

Institute of Biochemistry and Food Chemistry, University of Hamburg, Hamburg, Germany[1], Food Research Program, Agriculture and Agri-Food Canada, Guelph, ON, Canada[2], and Research Institute for the Biology of Farm Animals, Dummerstorf, Germany[3]

Beef meat was obtained from animals raised on pasture, fed a total mixed ration (barn), or obtained from retail stores April 2006 in Hamburg, Germany. The lipid composition of beef meat contains a mixture of *O*-acyl and *O*-alkenyl ether moieties linked to glycerol or *N*-acyl moieties attached to sphingosine. For the complete analysis of beef lipids a combination of derivatization techniques were used taking into consideration conjugated double bond moieties that isomerize under acid condition, *O*-alkenyl ethers that are stable under alkali conditions, *N*-acyl bonds that require extensive acid-catalyze treatment, and *O*-acyl lipids that are easily converted under either acid or base condition. In addition, the lipid moieties in ruminants are a complex mixture of isomers differing in chain length (C10 to C26), normal and branch chains, number of double bonds (0 to 6), and geometric and positional isomers. Prior and complimentary separation techniques were used to separate geometric isomers and fatty acid methyl esters from dimethylacetals (DMA) derived from the *O*-alkenyl ether moieties. Two GC temperature programs were employed using the highly polar 100 m capillary columns to adequately resolve most of the positional and geometric isomers. This is the first report that quantitates and characterizes total lipids of beef meat. The meat from pasture-fed beef shows high levels of 11*t*-18:1, 9*c*11*t*-CLA and 11*t*13*c*-CLA, while beef raised under intensive conditions show increased amounts of 10*t*-18:1, 7*t*9*c*-CLA, 9*t*11*c*-CLA and 10*t*12*c*-CLA. The retail beef appeared to be an equal mixture of the two. The total DMA content was higher in pasture (1.6%) than barn fed beef (2.5%), and showed a similar pattern in the *trans*-18:1 isomer composition.

CNC_528

Supplementation of an extract from *Ascophyllum nodosum* seaweed to media improves cellular monounsaturated fatty acids accumulation in differentiating 3T3-L1 adipocytes.

He, M.L., Wang, Y., You, J.S., Mir, P.S., McAllister, T.A.

Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada T1J 4B1

This study was designed to determine effect of a mixture that was extracted with 80% ethanol from *Ascophyllum nodosum* seaweed on cell differentiation and fatty acid accumulation in 3T3-L1 adipocytes. The 3T3-L1 preadipocytes in the density of 2×10^4 per ml were seeded to 48 wells, distributed in two 24-well plates and allowed to proliferate to confluence. Cells were treated with media containing 0, 12.5, 25, 50, 75, 100 micro g per ml media of the seaweed extract during both early (day 1-2) and intermediate & late differentiation periods (day 3-8). Dexamethasone, methyl-isobutylxanthine and insulin (DMI) containing media were applied during the early period to induce cell differentiation. Cells were visualized in two sub sets of the wells with Oil Red-O stain and those in the remaining wells were harvested on day 8 for determination of cellular fatty acid. Supplementation with the seaweed extract increased ($P<0.01$, n=6), concentration of cellular monounsaturated fatty acids including myristoleic acid (C14:1), palmitoleic acid (C16:1) and oleic acid (C18:1) without affecting ($P>0.05$, n=6) the cell number and total cellular fatty acid concentration. The ratios of C14:0/C14:1 fatty acid and C16:0/C16:1 fatty acid declined ($P<0.05$, n=6) in dose-dependent manner. The results suggest that the extract from *Ascophyllum nodosum* seaweed may contain certain bioactive factors which could increase desaturation of those *de novo* synthesized fatty acids.

Key words: adipocytes, fatty acids, seaweed

CNC_552

Fatty acids profile in breast milk of lactating mother consuming a galactogogue, coleus amboinicus lour.

*Damanik, Rizal**

Department of Community Nutrition, Faculty of Human Ecology, IPB University, Bogor-Indonesia.

Traditional knowledge of medicinal plants is an integral part of a culture's understanding of health and disease. Every culture on earth has herbalist lore, a storehouse of knowledge handed down over the generations. An example of this is the traditional practice among the Bataknese lactating women in North Sumatra, Indonesia, of consuming the leaves of Torbangun (Coleus amboinicus Lour) during the first 30 days after giving birth. They believe that this plant stimulates breast milk production. The intervention study conducted in Simalungun, North Sumatra, Indonesia, showed that the mother subjects in the Torbangun Group produced more milk than did subjects in the Reference Group. Breast milk contains a full complement of all polyunsaturated fatty acids (PUFA), including the two essential PUFA, linoleic acid (C18:2-ω6) and α- linolenic acid, and also a range of long chain (LC) PUFA that have been shown to have benefits for both preterm and term infants.

The present study reports fatty acid composition in breast milk of lactating mother who received one of three different supplements, namely Torbangun leaves, Moloco+B12™ Tablets and Fenugreek Capsules for 30 days. The subjects were to be followed up for another 30 days after the supplementation was completed.

Results collected from this study showed that the linoleic acid (C18:2-ω6) content in transitory milk (Day 8) of the Torbangun Group was significantly lower than for the Reference Groups. Further, it was observed that the linoleic acid content of the Torbangun Group remained increase until Day 60 and the increase was significantly higher than for the Reference Group. The residual effect of Torbangun supplementation during the first month of lactation can be seen even after the supplementation was ended for one month. The observations in the present study of the increase in milk production in the Torbangun Group has confirmed the beliefs amongst Bataknese people that Torbangun can be used as galactogogue in humans.

Key words: Torbangun, Bataknese, Coleus amboinicus Lour, Indonesia

DEPARTMENT OF COMMUNITY NUTRITION,
FACULTY OF HUMAN ECOLOGY, IPB UNIVERSITY, BOGOR-INDONESIA

FATTY ACIDS PROFILE IN BREAST MILK OF LACTATING MOTHER CONSUMING A GALACTOGOGUE, COLEUS AMBOINICUS LOUR

Drh. Rizal Damanik, M.Rep.Sc., Ph.D

The paper is presented at the Canadian Nutrition Congress on June 18-21, 2007 in Winnipeg Canada.

ABSTRACTS

FATTY ACIDS PROFILE IN BREAST MILK OF LACTATING MOTHER CONSUMING A GALACTOGOGUE, *COLEUS AMBOINICUS* LOUR.

DAMANIK, RIZAL*
Department of Community Nutrition, Faculty of Human Ecology, IPB University, Bogor-INDONESIA.

Traditional knowledge of medicinal plants is an integral part of a culture's understanding of health and disease. Every culture on earth has herbalist lore, a storehouse of knowledge handed down over the generations. An example of this is the traditional practice among the Bataknese lactating women in North Sumatra, Indonesia, of consuming the leaves of Torbangun (*Coleus amboinicus* Lour) during the first 30 days after giving birth. They believe that this plant stimulates breast milk production. The intervention study conducted in Simalungun, North Sumatra, Indonesia, showed that the mother subjects in the Torbangun Group produced more milk than did subjects in the Reference Group. Breast milk contains a full complement of all polyunsaturated fatty acids (PUFA), including the two essential PUFA, linoleic acid (C18:2-ω6) and α- linolenic acid, and also a range of long chain (LC) PUFA that have been shown to have benefits for both preterm and term infants.

The present study reports fatty acid composition in breast milk of lactating mother who received one of three different supplements, namely Torbangun leaves, Moloco+B12™ Tablets and Fenugreek Capsules for 30 days. The subjects were to be followed up for another 30 days after the supplementation was completed.

Results collected from this study showed that the linoleic acid (C18:2-ω6) content in transitory milk (Day 8) of the Torbangun Group was significantly lower than for the Reference Groups. Further, it was observed that the linoleic acid content of the Torbangun Group remained increase until Day 60 and the increase was significantly higher than for the Reference Group. The residual effect of Torbangun supplementation during the first month of lactation can be seen even after the supplementation was ended for one month. The observations in the present study of the increase in milk production in the Torbangun Group has confirmed the beliefs amongst Bataknese people that Torbangun can be used as galactogogue in humans.

Key Words: Torbangun, Bataknese, *Coleus amboinicus* Lour, Indonesia

INTRODUCTION

Breast milk is complex and presents continuous changes. The composition and volume of breast milk varies with each individual mother, the demands made by the infants, the time of the day, the nutritional status of the mother, and whether the milk is suckled or expressed (Emmet & Rogers, 1997). The content of breast milk is changed as lactation proceeds and presumably as the requirement of the infant changes, so the mother's diet is important (Harding, 2001; Mora & Nestel, 2000).

An intervention study was conducted to examine the lactagogue properties of CA and Fenugreek in lactating women in Simalungun, North Sumatra Indonesia. This paper reports the effects of CA and Fenugreek on the fatty acid composition of breast milk, in comparison with those of Moloco+B12™.

MATERIALS AND METHODS

Of 75 mother subjects recruited, 67 participated for the whole two-month study period. Subjects were divided into three groups: Moloco+B12™ (Reference Group, n = 22), CA Group (n = 23) and Fenugreek Group (n = 22).

Breast milk samples were collected from the subjects for nutrient analysis (macronutrients, minerals and fatty acids) over three occasions. To let infants consume colostrum, the first milk collection was conducted on Day 8 post partum and was used as Baseline for comparison with the information subsequently collected on second and third collections. The second collection was conducted one day after the completion of a 30-day supplementation period (Day 33). And the third collection was conducted at the end of the study period (Day 60). Over the two-month study period, the volumes of the 24-h breast milk intake were recorded on Days 14, 28, 42 and 56 post partum. The terminology "transitory milk" for Day 8 and "mature milk" for Day 33 and 60 sometimes are used in paragraphs in interpreting the data.

The effects of CA and Fenugreek were examined by comparing the percentage changes in the volume and nutritional quality of breast milk (using the values of the first measurements as the baseline, i.e. Day 14 for milk volume and Day 8 for milk nutrient contents) with those of the Reference Group.

RESULTS

Breast Milk Quantity

The 24-h breast milk intakes were recorded every 2 weeks over the two-month period, and the results are shown in Table 1.

Table 1 The breast milk intake during the two-month study period (mL)

Parameter	Reference Group		CA Group		Fenugreek Group	
	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD
Day 14 (baseline)	22	453.8 ± 192.6	23	361.1 ± 201.1	22	466.9 ± 253.0
Day 28	22	385.1 ± 201.9	23	478.7 ± 157.0 *	22	400.3 ± 215.1
Day 42	22	387.4 ± 188.3	23	439.8 ± 196.7	22	456.6 ± 247.1
Day 56	22	385.5 ± 170.5	23	478.3 ± 265.0	22	358.5 ± 135.2

No significant differences from the Reference Group (Moloco+B12™) were observed at Day 14 (ANOVA).

Significant differences from Day 14 within the same group (paired *t*-test): *, $P < 0.05$.

The information on 24-h breast milk intake was collected for the first time on Day 14 post partum, and was used as the Baseline for comparison with the information subsequently collected on Day 28, 42 and 56. Table 1 shows that although the mean milk volume at Day 14 of the CA Group was 361 mL, and about 100 mL less than that of the Reference and Fenugreek Groups (454 and 467 mL, respectively), statistical analysis showed that there were no significant differences amongst these three groups.

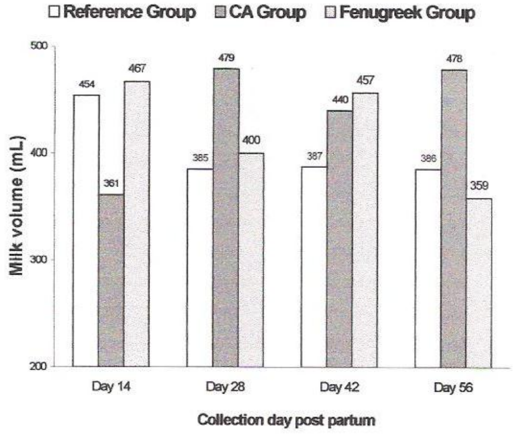

Figure 1
24-h breast milk intake during the two-month study period

It was observed that during the last two weeks of CA supplementation (from Day 14 to Day 28), the 24-h breast milk intake significantly increased from 361 to 479 mL ($P < 0.05$) or the average increase was 65% (Table 2). This increase was higher than with the groups receiving Moloco+B12™ Tablets or Fenugreek Capsules which were only 10% and 20% respectively. Additionally, it was found that, even after the completion of supplementation, the increase in breast milk intake of the CA Group still remained higher than the other two groups (Table 2).

Table 2 % Change in breast milk intake during the two-month study period

Parameter	Reference Group		CA Group		Fenugreek Group	
	N	Mean ± SD	n	Mean ± SD	n	Mean ± SD
Changes from Day 14 to						
Day 28	22	9.7 ± 97.7	23	65.2 ± 83.8	22	20.3 ± 105.7
Day 42	22	−1.2 ± 56.1	23	53.5 ± 95.2 *	22	19.6 ± 80.1
Day 56	22	−4.2 ± 44.1	23	68.4 ± 139.1 *	22	5.0 ± 67.2

Significant difference from the Reference Group (Moloco+B12™) (ANOVA): *, $P < 0.05$.

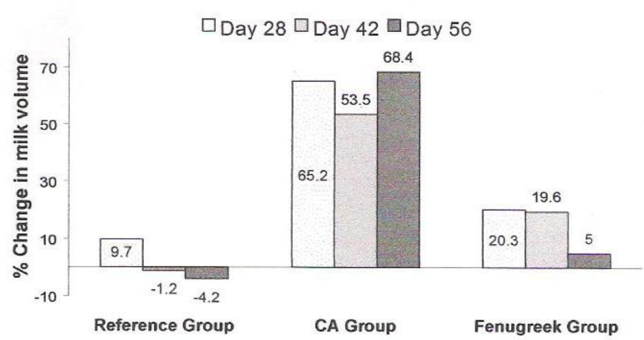

Figure 2

% Change in 24-h milk volume

Fatty acid contents

As shown in Table 3, saturated fatty acids constituted 38% of the total fatty acid in the transitory milk (Day 8) of the CA Group. This value was significantly higher (P < 0.001) than for the Reference Group (28%). The saturate of lauric acid (C12:0), myristic acid (C14:0) and palmitic acid (C16:0) contents of the transitory milk in the CA Group contributed to a higher content of saturated fatty acids of the CA Group than the Reference Group. The content of these fatty acids in the CA Group was significantly higher than the Reference Group. The saturate of decanoic (C10:0) and stearic acid (C18:0) in the CA Group were comparable to the Reference Group (0.8% vs 09% and 4% vs 3.6% respectively).

Table 3 Saturated fatty acid contents during the two-month study period (% by weight)

Parameter	Reference Group		CA Group	
	n	Mean ± SD	n	Mean ± SD
Day 8				
Decanoic (C10:0)	22	0.9 ± 0.4	22	0.8 ± 0.4
Lauric acid (C12:0)	22	6.4 ± 2.7	23	9.7 ± 6.0 [a]
Myristic acid (C14:0)	22	2.6 ± 1.0	23	4.5 ± 2.9 [b]
Palmitic acid (C16:0)	22	15.1 ± 1.1	23	19.3 ± 3.1 [d]
Stearic acid (C18:0)	22	3.6 ± 0.7	23	4.0 ± 1.1
Total	22	28.6 ± 5.9	23	38.3 ± 13.5 [d]
Day 33				
Decanoic (C10:0)	22	1.2 ± 0.4 §	23	1.5 ± 0.5 ¶
Lauric acid (C12:0)	22	7.2 ± 2.3	23	10.9 ± 5.6
Myristic acid (C14:0)	22	2.4 ± 0.8	23	3.2 ± 1.4 Ŧ
Palmitic acid (C16:0)	22	15.0 ± 1.4	23	16.6 ± 2.0 ¶
Stearic acid (C18:0)	22	3.8 ± 0.5	23	4.0 ± 0.7
Total	22	29.6 ± 5.4	23	36.2 ± 10.2
Day 60				
Decanoic (C10:0)	22	1.2 ± 0.4 Ŧ	23	1.0 ± 0.2
Lauric acid (C12:0)	22	7.7 ± 2.9	23	6.3 ± 2.3 *
Myristic acid (C14:0)	22	2.5 ± 0.9	23	2.5 ± 0.9 Ŧ
Palmitic acid (C16:0)	22	15.0 ± 0.9	23	15.9 ± 1.3 ¶
Stearic acid (C18:0)	22	3.9 ± 0.6	23	4.0 ± 0.5
Total	22	30.3 ± 5.7	23	29.7 ± 5.2

Significant difference from the Reference Group (Moloco+B12™) at Day 8 (ANOVA): [a], $P < 0.05$; [b], P < 0 01; [c], $P < 0.001$; [d], $P < 0.0001$.

Significant difference from Day 8 within the same group (paired t-test): *, $P < 0.05$; Ŧ, $P < 0.01$; §, $P < 0.001$; ¶, $P < 0.0001$.

After the completion of supplementation (Day 33), the decanoic acid (C10:0) content in mature milk of the CA Group was significantly higher than Day 8 (0.8 vs 1.5, $P < 0.0001$). The C10:0 content of this group showed a greater rise from Day 8 to Day 33. Statistical analysis showed that the rise in the CA Group was significantly higher than in the Reference Group (Table 7.8). The rise of C10:0 content in the CA Group continued until day 60. However, statistical analysis showed no significant difference in the rise of C10:0 content in breast milk between the CA and the Reference Groups.

Although the lauric acid (C12:0) content in the mature milk of the CA Group on Day 33 was comparable to the transitory milk (Day 8), it was observed that the C12:0 decreased significantly on Day 60 (9.7 vs 6.3, $P < 0.05$). Statistical analysis shows that the decrease of C12:0 in the CA Group was significantly higher than in the Reference Group (Table 4). Correspondingly, the myristic (C14:0) and palmitic (C16:0) contents of breast milk in the CA Group also showed a decline from Day 33 to Day 60. Table 4 showed that the decline of these fatty acids was significantly higher than in the Reference Group.

Table 4 % Change in saturated fatty acid content during the two-month study period

Parameter	Reference Group		CA Group	
	n	Mean ± SD	n	Mean ± SD
<u>% Change from Day 8 to Day 33</u>				
Decanoic (C10:0)	22	50.1 ± 55.5	23	172.9 ± 267.3 *
Lauric acid (C12:0)	22	27.4 ± 54.4	23	48.1 ± 120.6
Myristic acid (C14:0)	22	4.0 ± 41.6	23	−18.8 ± 31.7 *
Palmitic acid (C16:0)	22	−1.3 ± 8.0	23	−13.0 ± 11.8 §
Stearic acid (C18:0)	22	4.3 ± 14.1	23	6.3 ± 26.4
<u>% Change from Day 8 to Day 60</u>				
Decanoic (C10:0)	22	64.0 ± 62.2	23	76.6 ± 148.2
Lauric acid (C12:0)	22	44.2 ± 76.6	23	−10.4 ± 65.5 *
Myristic acid (C14:0)	22	13.0 ± 58.4	23	−30.7 ± 36.2 ∓
Palmitic acid (C16:0)	22	−1.7 ± 9.2	23	−16.0 ± 13.6 §
Stearic acid (C18:0)	22	8.0 ± 19.8	23	5.1 ± 24.6

Significant difference from the Reference Group (Moloco+B12™) (ANOVA): *, $P < 0.05$; ∓, $P < 0.01$; §, $P < 0.001$.

The unsaturated fatty acid contents of the two comparison groups is shown in Table 5. The unsaturated fatty acids accounted for 29% of the total fatty acids of transitory milk (Day 8) and 33% of the total fatty acids of mature milk (Day 60) for the CA Group. Most of the unsaturates were monounsaturated fatty acids, which contributed 23% and 26% to the total fatty acid content of transitory and mature milk respectively. In the Reference Group, unsaturated fatty acids accounted for 33% of the total fatty acids of transitory milk and remained at a constant level for mature milk. As with the CA Group, the monounsaturated fatty acids were major fatty acids in the Reference Group. Monounsaturated of palmitoleic (C16:1) and polyunsaturated of linoleic acid (C18:2n-6) and linolenic acid (C18:3n-3) contents in the transitory milk (Day 8) of the CA Group were found to be considerably lower than in the Reference Group.

Table 5 Unsaturated fatty acid contents during the two-month study period (% by weight)

Parameter	Reference Group		CA Group	
	n	Mean ± SD	n	Mean ± SD
<u>Day 8</u>				
	22	25.7 ± 3.1	23	23.6 ± 5.3
Monounsaturated fatty acids				
Palmitoleic acid (C16:1)	22	2.0 ± 0.5	23	1.5 ± 0.9 [a]
Oleic acid (C18:1)	22	23.7 ± 2.6	23	22.1 ± 4.4
Polyunsaturated fatty acids	22	7.6 ± 1.3	23	5.6 ± 1.6
Linoleic acid (C18:2n-6)	22	7.1 ± 1.1	23	5.4 ± 1.3 [d]
Linolenic acid (C18:3n-3)	22	0.5 ± 0.2	23	0.2 ± 0.3 [c]
<u>Day 33</u>				
	22	26.6 ± 2.8	23	25.5 ± 3.5
Monounsaturated fatty acids				
Palmitoleic acid (C16:1)	22	1.9 ± 0.5	23	2.2 ± 0.9 Ŧ
Oleic acid (C18:1)	22	24.1 ± 2.3	23	23.3 ± 2.6
Polyunsaturated fatty acids	22	8.2 ± 2.0	23	6.9 ± 1.3
Linoleic acid (C18:2n-6)	22	7.7 ± 1.9	23	6.5 ± 1.2 Ŧ
Linolenic acid (C18:3n-3)	22	0.5 ± 0.1	23	0.4 ± 0.1
<u>Day 60</u>				
	22	25.5 ± 2.6	23	26.1 ± 2.8
Monounsaturated fatty acids				
Palmitoleic acid (C16:1)	22	1.8 ± 0.4 *	23	2.1 ± 0.6 *
Oleic acid (C18:1)	22	23.7 ± 2.2	23	24.0 ± 2.2
Polyunsaturated fatty acids	22	8.2 ± 1.7	23	7.3 ± 1.4
Linoleic acid (C18:2n-6)	22	7.7 ± 1.6	23	6.9 ± 1.3 ¶
Linolenic acid (C18:3n-3)	22	0.5 ± 0.1	23	0.4 ± 0.1

Significant difference from the Reference Group (Moloco+B12™) at Day 8 (ANOVA): [a], $P < 0.05$; [b], $P < 0\ 01$; [c], $P < 0.001$; [d], $P < 0.0001$.

Significant difference from Day 8 within the same group (paired *t*-test): *, $P < 0.05$; Ŧ, $P < 0.01$; §, $P < 0.001$; ¶, $P < 0.0001$.

The polyunsaturates of the linoleic acid (C18:2n-6) totaled 5.4% of the transitory (Day 8) and 6.9% of the mature milk (Day 60) fatty acids for the CA Group. In the Reference Group, the values were 7.1% and 7.7% respectively.

The linoleic acid (C18:2n-6) content of the CA Group showed a consistent rise until Day 60. This fatty acid rose from 5.4% on Day 8 to 6.9% on Day 60 ($P < 0.0001$). Statistical analysis showed that the rise of the C18:2n-6 content in the CA Group was significantly higher ($P < 0.0001$) than in the Reference Group (Table 6). In addition, the palmitoleic acid (C16:1) of the CA Group also elevated continually until Day 60 (1.5% to 2.1%, $P < 0.05$), and as shown in Table 6, this change was significantly different from that of the Reference Group (83.9% vs –9.5%, $P < 0.001$).

Table 6 % Change in unsaturated fatty acid contents during the two-month study period

Parameter	Reference Group			CA Group		
	n	Mean	± SD	n	Mean	± SD
% Change from Day 8 to Day 33						
Palmitoleic (C16:1)	22	-3.0	± 24.0	23	94.4	± 140.6 Ŧ
Oleic (C18:1)	22	1.8	± 10.1	23	9.7	± 27.7
Linoleic (C18:2)	22	10.7	± 30.7	23	26.9	± 34.5
% Change from Day 8 to Day 60						
Palmitoleic (C16:1)	22	-9.5	± 20.2	23	83.9	± 111.8 §
Oleic (C18:1)	22	1.0	± 14.5	23	13.7	± 32.2
Linoleic (C18:2)	22	10.2	± 28.9	23	36.1	± 43.6 *

Significant difference from the Reference Group (Moloco+B12™) (ANOVA): *, $P < 0.05$; Ŧ, $P < 0.01$; §, $P < 0.001$.

Note: Most of the Linolenic (C18:3) values are zero, and % change values are not calculated.

DISCUSSION

Quantity of Breast Milk

A key element defining lactation performance is the total amount of milk produced. The most widely accepted method for measuring milk intake is test weighing, a procedure in which the infant is weighed before and after each feeding, preferably using a balance scale accurate to ± 5 g. In this method, milk intake is usually underestimated by approximately 1-5% (Brown et al., 1982) because of evaporative water loss from the infant between weighing.

The findings that the 24-h milk intake of the CA Group increased by 65% from Day 14 to Day 28, while that of Reference and Fenugreek Groups increased only 10% and 20%, respectively, suggest that the breast milk production was enhanced by the CA soup. Furthermore, it was also observed that, even though the supplementation period was already over, the milk volume in the CA Group on Day 56 still remained increased while there was a decline in the milk volume in the other two intervention groups, especially in the last two weeks of the follow-up period. During 2 months lactation, the milk volume in the Fenugreek Group was found to be lowest amongst the Reference and CA Groups (358mL vs 385mL vs 478mL, respectively). However, the nutritional quality of milk samples of the CA Group needs to be further examined.

The effect of CA on the proliferation of mammary secretory cells, which is used an indicator for the activity of the secretory cells in secreting milk (Knight et al., 1984), has already been shown in an animal study (Silitonga, 1993). In that study, lactating mice were supplemented with various doses of a CA extract from Day 2 post partum for 28 days. The 75% and 75.3% increases in DNA and RNA levels in the mice receiving the CA extract 60 g/kg body weight, compared to the 22.5% decrease in DNA and 26% increase in the RNA observed in the mice receiving Moloco+B12™ supplement ($P < 0.05$), indicating that CA could increase the proliferation of mammary secretory cells. It was also found that the effect of CA on the proliferation of secretory cells in the mammary gland was dose-dependent (Silitonga, 1993).

Fatty Acid Contents

It has been shown in several studies that the composition of the fat consumed by the mother will influence the fatty acid composition of milk (Chen et al., 1997; Chulei et al., 1995; Francois et al., 1998; Kneebone et al., 1985).

In the present study, it was anticipated that there would be changes, to some extent, in the fatty acid contents in milk samples of the CA Group. This was because CA was supplemented as a soup that had coconut milk and chicken, apart from CA leaves, as the main ingredients. Fatty acid analysis showed that the CA soup was a good source of saturated fatty acids, especially lauric acid (C12:0), and linoleic acid (C18:2). And indeed, the lauric and linoleic acid contents were increased by 48% and 27%, respectively, at the end of the one-month CA supplementation. However, the more striking increases were found in decanoic (C10:0, 173%) and palmitoleic (C16:1, 95%) acid contents.

The high increase in decanoic acid (C10:0) and lauric acid (C12:0) suggested that high consumption of saturated acids through coconut milk of CA supplement was associated with the biosynthesis of high levels of intermediate and medium (C6:0 to C12:0) saturated fatty acids. This finding is in agreement with previous reports (Kneebone et al., 1985).

It has been established that fatty acid composition of human milk varies as lactation progresses (Luukkainen et al., 1994; Makrides et al., 1995). From colostrum to mature milk, the contents of essential fatty acids C18:2n-6 and C18:3n-3 in human milk increase, whereas the percentage of long-chain polyunsaturated fatty acid of both the n-6 and n-3 series decrease (Luukkainen et al., 1994). The present study has demonstrated that PUFA concentrations in breast milk of two groups studied changed during lactation. The significance difference was observed in the CA Group where the PUFA concentrations of linoleic acid (LA; C18:2n-6) showed a change from the transitory milk on Day 8 (5.4%) to the mature milk on Day 33 (6.5%) and Day 60 (6.9%).

Compared with other fatty acids, unsaturated fatty acids, especially LC-PUFAs, in milk exhibited a delay in peak values (at 24 hours of ingestion) and showed prolonged elevation in breast milk, possibly because the body pool size of these fatty acids is small (Francois et al., 1998).

Although the essential fatty acid content of the breast milk in the CA Group was lower than the Reference Group, however, it is observed that the C18:2n-6 to C18:3n-3 ratio in this group was higher than in the Reference Group (27% vs 14.2%, respectively). Because linoleic acid (C18:2n-6) and α-linolenic acid (C18:3n-3) both are known to compete for the same enzyme for further desaturation and chain elongation polyunsaturated fatty acids (LC-PUFAs), the dietary ratio between these fatty acids is more important than the absolute intake of each of these essential fatty acids (Koletzko et al., 1992). The availability of LC-PUFAs (C>20-24), such as arachidonic acid (20:4n-6) and docosahexanoic acid (C22:6n-3), is important for early human growth and development. During late fetal and early postnatal growth, considerable amount of fatty acids (both n-6 and n-3) is incorporated in neural and other tissues. Brain lipids of newborn infants contain about twice as much (n-6) LC-PUFAs as (n-3) LC-PUFAs (Koletzko & Muller, 1990).

The present study has shown that linoleic acid (C18:2n-6) content of breast milk in the CA Group exhibited a significant rise from Day 8 to Day 60 due to consumption of CA supplement. These findings lend support to the presumption that this fatty acid present in the CA supplement might stimulate the secretion of prostaglandin. This fatty acid can be desaturated and elongated to 20-carbon LC-PUFAs (eicosanoids) (Koletzko et al., 1992).

The secretory cell numbers in the mammary gland are positively correlated to milk yield. Therefore, the more secretory cells present, the more prolactin hormone produced in circulation. In the present study the increase of breast milk intake in the CA Group was higher than the other two groups. Thus, the high level of prolactin hormone circulating in the CA subjects would be important to support this presumption. Because oxytocin is essential for milk ejection in humans, the existence of this hormone in the circulation should be known to support this presumption.

CONCLUSION

The observations in the present study of the increase in milk production without compromising the nutritional quality in the CA Group has confirmed the belief amongst Bataknese people that CA can be used as a lactagogue in humans. The residual effect of CA supplementation during the first month of lactation can be seen even after the supplementation was ended for one month.

REFERENCES

Brown KH, Black RE, Robertson AD et al. Clinical and field studies of human lactation: methodological considerations. Am J Clin Nutr 1982; 35: 745-756.

Chen ZY, Kwan KY, Tong KK, et al. G. Breast milk fatty acid composition: a comparative study between Hong Kong and Chongqing Chinese. Lipids 1997; 32: 1061–1067.

Chulei R, Xiaofang L, Hongsheng M et al. Milk composition in women from five different regions of China: the great diversity of milk fatty acids. J Nutr 1995; 125: 2993-2998.

Emmet PM & Rogers IS. Properties of human milk and their relationship with maternal nutrition. Early Hum Dev 1997; 49(Suppl): S7-S28.

Francois CA, Connor SL,& Wander RC. Acute effects of dietary fatty acids on fatty acids of human milk. Am J Clin Nutr 1998;67: 301-308.

Harding J. The nutritional basis of the fetal origins of adult diseases. Int J Epidemiol 2001; 30: 15-23.

Kneebone GM, Kneebone R, Gibson RA. Fatty acid composition of breast milk from three racial Groups from Penang, Malaysia. Am J Clin Nutr 1985; 41: 765-769.

Koletzko B, RP Maria, H. Demmelmair, et al. Physiological aspects of human milk lipids. Early Hum Develop 2001; 65(Suppl): S3-S18.

Koletzko B, Thiel I, Abiodun PO. The fatty acid composition of human milk in Europe and Africa. J Pediatr 1992; 120(Suppl): S62–70.

Koletzko B & Muller J. Cis and trans-isomeric fatty acids in plasma lipids of newborn infants and their mothers. Biol Neonate 1990; 57: 172-178.

Koletzko B, M. Mrotzek and H.J. Bremer. Fatty acid composition of mature human milk in Germany. Am J Clin Nutr 1988; 47: 954–959.

Knight CH, Docherty AN & Peaker M. Milk yield in rats in relation to activity and size of the mammary secretory cells population. J Dairy Res 1984; 51: 29-35.

Luukkainen P, Salo MK & Nikkari T. Changes in the fatty acid composition of preterm and term human milk from 1 week to 6 months of lactation. J Ped Gastroenterol Nutr 1994; 18: 355-360.

Makrides M, Simmer K, Neumann M & Gibson R. Changes in the polyunsaturated fatty acids of breast milk from mothers of full-term infants over 30 wk of lactation. Am J Clin Nutr 1995; 61:1231-1233.

Mora, JO & Nestel PS. Improving prenatal nutrition in developing countries: strategies, prospect and challenges. Am J Clin Nutr 2000; 71: 1353S-63S.