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Omega-6 and Omega-3 Fatty Acid Content and Ratio of Commercial Complementary Foods

Ni Putu Eka Suwitri [a], **I Gusti Lanang Sidiartha** [b]

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Correspondence Author [b]

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Abstract

After 6 months old, the baby must be provided complementary foods (CFs) due to the breast milk only cannot meet the nutrients requirement. The essential nutrients that should be contained in CFs are omega-6 (n-6) and omega-3 (n-3) fatty acid. The study evaluated n-6 and n-3 fatty acid contents, as well n-6:n-3 ratios of commercial CFs on the market. An observational study was conducted on the biggest supermarket of Denpasar city on June 2016. The n-6 and n-3 contents and it ratios were determined depending on labels of each commercial CFs then compared with Indonesia Nutritional Adequacy Rate (NAR) according to the infant's age. Total 53 commercial CFs were included in this study, 48 of them contain n-6 and/or n-3 fatty acid, where is 40 as a porridge and 8 as biscuits. Most of the commercial CF (97.5%) contains omega-6 fatty acid and only 57.5% of them contain omega-3 fatty acid. While all of the biscuit forms only contain omega-3 fatty acid. The concentration of omega-6 and omega-3 fatty acid per 100 kcal was 302 mg and 39 mg, respectively with ratio 7.7:1. Compared with Indonesia NAR requirement of omega-6 and omega-3 fatty acid and it ratio according the infant's age there was not significantly different (p = 0.826). The concentration and ratio of omega-6 and omega-3 fatty acid in commercial CF was appropriate with Indonesia NAR according the infant's age.

Contents

[a] Department of Pediatrics, Medical Faculty, Udayana University
[b] Department of Pediatrics, Medical Faculty, Udayana University

1. Introduction

The quantity and quality of nutrition in the first 1000 days of life is essential for the future health of the child. This is a period of rapid growth and development of the body and brain, which will determine the physical and mental health of the child in the future life. Breast-milk only can be sufficient for the first 6 months of infant's life. Thereafter, complementary foods (CFs) should be given along with breast-milk to meet the additional energy and nutritional needs up to 2 years of age. Energy and nutrient density is an essential component of CFs to achieve their goal (Dewey: 2002), (Trumbo, *et al*.: 2002).

Complementary foods should be containing the entire nutrients that are needed by the infant such as carbohydrate, fats, protein, mineral, and vitamin. Part of fats that play an important role in the structure and function of various system organs in the body is essential fatty acid omega-6 (n-6) and omega-3 (n-3). Both of these fatty acids are classified as essential fatty acids because the body cannot synthesize these fatty acids. So, all CFs should be containing n-6 and n-3 fatty acid to prevent deficiency. Besides the amount of these fatty acids, the ratio between n-6:n-3 is also important to prevent several diseases that associate with inflammation processes. A high ratio of n-6:n-3 in daily foods intake have been reported associated with coronary heart disease. In early life, essential fatty acids deficiency is associated with low cognitive performance. A clinical study reported that n-3 fatty acid supplementation improves cognitive function due to elevated levels of hippocampal acetylcholine, anti-inflammatory effects, decreased cardiovascular disease risk and increased of neuroplasticity (Simopoulos: 2000). In the first 1000 days – during pregnancy through the child's second birthday - total n-6 and n-3 as well n-9 fatty acids increases in the frontal lobe of the brain (Auestad, *et al*.: 2003), (Simopoulos: 2002).

Based on the Minister of Health of Indonesia regulation number 75/2013, the Nutritional Adequacy Rate (*Angka Kecukupan Gizi*) for n-6 and n-3 fatty acid according to the infant's age is 4.4 g/day and 0.5 g/day, 7.0 g/day and 0.7 g/day for infant aged 0-11 months and 1-3 years, respectively. The ratio between n-6 and n-3 fatty acid that recommended was 10:1. Energy sources from CFs for infant aged 6-8 months, 9-11 months, and 12-23 months are 200 kcal/day, 300 kcal/day, and 550 kcal/day, respectively. This energy is needed to complete the gap between total energy requirement and energy from breast milk (Saparinto & Hidayati (2006).

Conventional CFs that is prepared at home, commonly cereal-based mixed with vegetables without sources of n-6 and n-3 fatty acid. This fact is at risk to become inadequate intake of n-6 and n-3 fatty acid with their consequences. Recently, commercial CFs, which is fortified by n-6 and n-3 fatty acid, is widely sold in the market. This study aims to find out the n-6 and n-3 fatty acid content of commercial CFs, as well their ratio in the supermarket around Denpasar city, Bali Indonesia. The content of it is compared with Indonesia Nutritional Adequacy Rate according to the infant's age.

2. Research Method

The observational study was conducted on commercial CFs products in the biggest supermarket in Denpasar city, Bali Indonesia in June 2016. The purposive sampling was done to choose the biggest supermarket in Denpasar city. The biggest supermarket was chosen to ensure the availability all of the commercial CFs products.

Complementary foods are the transition foods from exclusive breastfeeding to family foods, which are commonly given on period from 6 months to 18-24 months of age, when breast milk is no longer enough to meet the nutritional needs of the infant. Commercial CFs is the CFs that is made by the factory, which is fortified with the important nutrients, including n-6 and n-3 fatty acid. The concentration of n-6 and n-3 fatty acid is determined by the value that is written on the product's label. Based on Nutritional Adequacy Rate (*Angka Kecukupan Gizi*) of Indonesian people, infant aged 0-6 months, 7-11 months, and 1-3 years are needed n-6 and n-3 fatty acid per 100 kcal 800 mg/day and 90 mg/day, 606 mg/day and 68 mg/day, and 622 mg/day and 62 mg/day, respectively. The ratio of n-6:n-3 fatty acid is 8.8-10:1.

All product of commercial CFs that were sold in the biggest supermarket in Denpasar city was chosen as a sample. The mean concentration of n-6 and n-3 fatty acid on commercial CFs was compared with Nutritional Adequacy Rate (*Angka Kecukupan Gizi*) and analyzed using Independent t-test with significances if P value < 0.05. Ethic committee of Udayana University – Sanglah General Hospital had been approved the study.

3. Results and Analysis

Total 53 commercial CFs including in this study. Forty-eight of 53 commercial CFs or 90.5% contain n-6 and/or n-3 fatty acid. From 48 commercial CFs, 40 in a porridge form and the rest in a biscuit form. On the porridge form of commercial CFs that is written on the label is indicated for different aged of an infant that is 6 months or above, 8 months or above, and 9 months or above. Completely data of commercial CFs is showed in the following table.

Table 1
Characteristics of commercial CFs

Characteristic	n = 48
CFs form, Porridge, n (%)	40 (83.3)
Biscuit, n (%)	8 (16.7)
Porridge form	
Indicated for 6 months, n (%)	23 (57.5)
8 months, n (%)	9 (22.5)
9 months, n (%)	8 (20.0)
Content of n-6 only, n (%)	13 (32.5)
n-3 only, n (%)	5 (12.5)
n-6 and n-3, n (%)	22 (55.0)
Concentration/100 kcal	
n-6 (mg), mean (SD)	229.5 (196.9)
n-3 (mg), mean (SD)	38.0 (27.2)
Biscuit form	
Indicated for 6 months, n (%)	8 (100)
Concentration/100 kcal, n-3 (mg), mean (SD)	4.3 (0.68)

Based on 23 products of porridge CF for age 6 months and above, 11 products do not contain omega-3. From products of porridge CF for age 8 months and above, 4 products do not contain omega-3. From products of porridge/steamed rice CF for age 9 months and above, only 1 product that does not contain omega-6 and 2 products do not contain omega-3. All biscuit products for age 6 months and above do not contain omega-6. Most of the commercial CF (97.5%) contains omega-6 fatty acid and only 57.5% of them contain omega-3 fatty acid. While all of the biscuit forms only contain omega-3 fatty acid (Willatts, *et al*.: 1998, Mataram, *et al*.: 2017).

All manufacturers include instructions for use and suggestions of servings. The serving of the various products is different, whereby the porridge product for age 6 months and above ranges between 40-50 gram (5-6 tablespoons) per serving for porridge and steamed rice and 19-21 grams per serving (2-3 pieces) for biscuits. On the packaging label listed suggestion 2 times a day for porridge for age 6 months and above and 2-3 times a day for porridge for age 8 months and 9 months and above. The number of calories per serving porridge and the steamed rice between 160-210 calories, while the number of calories per serving of biscuit between 80-90 calories. Porridge products for age 8 years and above have energy ranges per serving 100 calories in 25 grams of serving. While the product of porridge/steamed rice for age 9 months and above was obtained 25-50 grams per serving with the number of calories ranging from 100-210 calories per serving.

Table 2
Omega-6 and Omega-3 Content of Commercial CFs

Products	Omega-6	Mean difference; 95% CI	p-value	Omega 3	Mean difference; 95% CI	p-value
Porridge						
Product mg/100 kcal (mean, SD)	229.5 (196.9)	-376.4; -782.4-29.58	0.068	38.0 (27.2)	-29.9; -87.6-27.6	0.292
NAR (mg/100 kcal)	606			68.0		

Table 2 showed the mean of omega-6 and omega-3 levels found in the porridge products 229.5 (196.9) and 38.0 (27.2) mg/100 kcal. In biscuit products 6 months and above omega-3 levels obtained is 4.3 (0.68) mg/100 kcal while omega-6 is not contained in all biscuit products. Analysis of mean difference between omega-3 and omega-6 by NAR 2013 was obtained p-value of porridge product omega-6 and omega-3 that is p = 0.068 and p = 0.292 respectively.

Table 3
Ratio Levels of Omega-6 and Omega-3 Compared with Recommendation of NAR 2013

Products	Ratio	Mean difference; CI 95%	p-value
Porridge form (mean, SD) Products	7.9 (4.3)	-0.9; -10.2-8.3	0.809
NAR	8.9		

Complementary foods in developing countries are often low in fat and essential fatty acids, which are required for growth and development. Fortified commercial CF may need to contain higher proportions of these nutrients. The amount of fat in the total diet is recommended to be at least 35% of energy, and 35-45 percent is considered to be advantageous for most CF if the density of micronutrients is adequate (World Health Organization: 2009). This study found that most of the commercial CFs contain n-6 and n-3 fatty acid. It is a good fact because n-6 and n-3 fatty acid is an important nutrient to support the structure and function of many organs, particularly the brain. Fat is an important component found in infants and children foods because it contains essential fatty acids, which can help the absorption of fat-soluble vitamins and increase the energy density of food. The percentage of energy from fat in the required CF depends on the amount of breast milk and the fat content of breast milk (Marangoni, et al.: 2000).

Breast milk is a good source of fatty acids for infants before age 6 months, but after that, the levels of fatty acids in breast milk are no longer adequate to support the baby's needs. Therefore, CF should be immediately given to infants over 6 months, and foods must contain lots of essential fatty acids so that the needs of fatty acids can still be fulfilled optimally.[7] Breast milk production levels is decreasing with increasing age, so at the age of 6 months and above it is necessary to add complement foods other than breast milk to meet the daily level of essential fatty acids (Uauy & Castillo (2003).

Brain, retina and neural networks are very rich in long-chain polyunsaturated fatty acids (LC-PUFA). Long-chain polyunsaturated fatty acids (LC-PUFAs) have an important role as membrane structural components in tissue systems, including blood vessel tissue. Some LCPUFAs (omega-6 and 3) are precursors to the production of eicosanoids including prostaglandins, prostacyclin, thromboxane, and leukotrienes (Kusumayanti & Dewantari: 2017). These autocrine and paracrine mediators are powerful regulators of many cell and tissue functions such as platelet aggregation, inflammatory reactions and leukocyte function, vasoconstriction and vascularization, blood pressure, bronchial constriction and uterine contractility (Engler, et al.: 1999). Supplementation with LC-PUFA has been shown to decrease blood pressure in hypertensive people (Forsyth, et al.: 2003). Another study suggests that children who,

when they were younger on formula supplemented with LC-PUFA, at 6 years of age had lower blood pressure levels than children who consume unsupplemented formula milk (Kelishadi, et al. (2012).

At the age 6-8 months, the total energy required for breast milk is about 486 kcal per day while from CF about 196 kcal per day. In CF products contained in the market contains 160-210 kcal per serving. To meet the energy needs, children aged 6-8 months need to consume 1-2 servings of CF a day. At the age of 9-11 months total energy required from breast milk about 375 kcal per day while from the CF about 455 kcal per day. In CF products contained in the market contains 100-210 kcal of the study. To meet the energy needs, children aged 9-11 months need to consume 3-4 portions a day, depending on the products consumed and nutritional snack added such as fruit or biscuits. In this study, the level of omega-6 and omega-3 compared with the adequacy of omega-3 and 6 based on NAR 2013, there is no significant difference (Saxena: 2017, Puryana & Antarini (2018).

Besides CF, children also still require breastmilk intake to meet the nutritional needs. Breast milk itself contains fatty acids that children need. However, the content of fatty acids in breast milk is influenced by several factors including maternal consumption habits, maternal fatty acid metabolism, maternal fat reserves, and lactation period (Martin, *et al*.: 2012, Scopesi, *et al*.: 2001). Martin *et al*. (2012) reveal diet will affect the composition of breast milk fatty acids both directly and by uptake in the body (Gao, *et al*.: 2013). It has been reported that breastfed infants have higher IQs and show better progression testing than formula-fed infants (Szabó, *et al*.: 2010).

Fatty acids contained in exclusive breastfeeding has the highest levels of omega-3 which is equal to 28.24% while the omega-6 of 0.57%. Omega-3 is considered one of the essential fatty acids because the body is unable to produce it so it needs to be obtained from food. Omega-3 has many health benefits including anti-inflammatory and anti-clotting effect and has the effect of preventing heart disease and cancer. Meanwhile, omega-6 is an essential fatty acid that has a pro-inflammatory effect (Dalzell, *et al*.: 2010).

In this study showed the omega-3 and omega-6 ratios that have been appropriate with NAR recommendation, in which there was no significant difference with the recommendation of NAR 2013. Increased omega-6 and omega-3 PUFA ratios in peripheral blood lead to excessive production of proinflammatory cytokines that increase the risk of inflammatory disease and are associated with depressive symptoms (Aryani, *et al*.: 2017).

In 1999, Simopoulos et al reported from Workshop on The Essentiality of and Recommended Dietary Intakes for Omega-6 and omega-3 fatty acids in Bethesda, Maryland, USA, that the ratio of omega-6 fatty acids and omega-3 fatty acids to newborns should be kept between 4: 1 and 10: 1 (Robinson & Stone: 2006). The higher ratio will suppress the presence of omega-3 in vital organs. Omega-3 metabolism is assisted competitively by using the same enzyme. Excessive administration of omega-3 may suppress the process of formation of Arachidonic Acid (AA), and may suppress the activity of cyclooxygenase enzyme which facilitates the formation of prostaglandins from AA or omega-6, thereby inhibiting the formation of prostaglandins following thromboxane and leukotriene, which may lead to delayed response to the process inflammation, particularly in the release of interleukin-1 and tumor necrosis factor (TNF), prolonged bleeding, decreased renin contributing to kidney function control (Simopoulos, et al.: 1999).

4. Conclusion

Most of the commercial CF contains omega-6 and omega-3 fatty acid. The concentration and ratio of omega-6 and omega-3 fatty acid in commercial CF were appropriate with Indonesia Nutritional Adequacy Rate according to the infant's age. It is recommended to consume commercial CF that contains omega-6 and omega-3 fatty acid with an appropriate ratio.

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References

1. Dewey, K. (2002). Guiding principles for complementary feeding of the breastfed child. View in (Google Scholar)

2. Trumbo, P., Schlicker, S., Yates, A. A., & Poos, M. (2002). Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein and amino acids. *Journal of the American Dietetic Association*, *102*(11), 1621-1630. View in (Google Scholar)

3. Simopoulos, A. P. (2000). Human requirement for N-3 polyunsaturated fatty acids. *Poultry science*, *79*(7), 961-970. View in (Google Scholar)

4. Auestad, N., Scott, D. T., Janowsky, J. S., Jacobsen, C., Carroll, R. E., Montalto, M. B., ... & Connor, S. L. (2003). Visual, cognitive, and language assessments at 39 months: a follow-up study of children fed formulas containing long-chain polyunsaturated fatty acids to 1 year of age. *Pediatrics*, *112*(3), e177-e183. View in (Google Scholar) (CrossRef)

5. Simopoulos, A. P. (2002). The importance of the ratio of omega-6/omega-3 essential fatty acids. *Biomedicine & pharmacotherapy*, *56*(8), 365-379. View in (Google Scholar) (CrossRef)

6. Saparinto, C., & Hidayati, D. (2006). *Bahan tambahan pangan*. Kanisius. View in (Google Scholar)

7. World Health Organization. (2009). Infant and young child feeding: model chapter for textbooks for medical students and allied health professionals. View in (Google Scholar)

8. Marangoni, F., Agostoni, C., Lammard, A. M., Giovannini, M., Galli, C., & Riva, E. (2000). Polyunsaturated fatty acid concentrations in human hindmilk are stable throughout 12-months of lactation and provide a sustained intake to the infant during exclusive breastfeeding: an Italian study. *British Journal of Nutrition*, *84*(1), 103-109. View in (Google Scholar) (CrossRef)

9. Uauy, R., & Castillo, C. (2003). Lipid requirements of infants: implications for nutrient composition of fortified complementary foods. *The Journal of nutrition*, *133*(9), 2962S-2972S. View in (Google Scholar) (CrossRef)

10. Engler, M. M., Engler, M. B., Kroetz, D. L., Boswell, K. D. B., Neeley, E., & Krassner, S. M. (1999). The effects of a diet rich in docosahexaenoic acid on organ and vascular fatty acid composition in spontaneously hypertensive rats. *Prostaglandins, Leukotrienes and Essential Fatty Acids (PLEFA)*, *61*(5), 289-295. View in (Google Scholar) (CrossRef)

11. Forsyth, J. S., Willatts, P., Agostoni, C., Bissenden, J., Casaer, P., & Boehm, G. (2003). Long chain polyunsaturated fatty acid supplementation in infant formula and blood pressure in later childhood: follow up of a randomised controlled trial. *Bmj*, *326*(7396), 953. View in (Google Scholar) (CrossRef)

12. Kelishadi, R., Hadi, B., Iranpour, R., Khosravi-Darani, K., Mirmoghtadaee, P., Farajian, S., & Poursafa, P. (2012). A study on lipid content and fatty acid of breast milk and its association with mother's diet composition. *Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences*, *17*(9), 824.
View in (Google Scholar)

13. Martin, M. A., Lassek, W. D., Gaulin, S. J., Evans, R. W., Woo, J. G., Geraghty, S. R., ... & Gurven, M. D. (2012). Fatty acid composition in the mature milk of Bolivian forager-horticulturalists: controlled comparisons with a US sample. *Maternal & child nutrition*, *8*(3), 404-418.
View in (Google Scholar) (CrossRef)

14. Scopesi, F., Ciangherotti, S., Lantieri, P. B., Risso, D., Bertini, I., Campone, F., ... & Serra, G. (2001). Maternal dietary PUFAs intake and human milk content relationships during the first month of lactation. *Clinical Nutrition*, *20*(5), 393-397.
View in (Google Scholar) (CrossRef)

15. Gao, Y. X., Zhang, J., Wang, C., Li, L., Man, Q., Song, P., ... & Frøyland, L. (2013). The fatty acids composition of colostrum in three geographic regions of China. *Asia Pacific journal of clinical nutrition*.
View in (Google Scholar) (PDF)

16. Szabó, É., Boehm, G., Beermann, C., Weyermann, M., Brenner, H., Rothenbacher, D., & Decsi, T. (2010). Fatty acid profile comparisons in human milk sampled from the same mothers at the sixth week and the sixth month of lactation. *Journal of pediatric gastroenterology and nutrition*, *50*(3), 316-320.
View in (Google Scholar) (CrossRef)

17. Dalzell, J., Rogerson, E., & Martindale, L. (2010). *Breastfeeding: contemporary issues in practice and policy*. Radcliffe Publishing.
View in (Google Scholar)

18. Aryani, T., Utami, F. S., & Sulistyaningsih, S. (2017). Identifikasi Asam Lemak Omega Pada Asi Eksklusif Menggunakan Kromatografi GC-MS. *Journal of Health Studies*, *1*(1), 1-7.
View in (Google Scholar)

19. Robinson, J. G., & Stone, N. J. (2006). Antiatherosclerotic and antithrombotic effects of omega-3 fatty acids. *American Journal of Cardiology*, *98*(4), 39-49.
View in (Google Scholar) (CrossRef)

20. Simopoulos A. P., Leaf A., Salem N. (1999). Workshop on the essentiality of and recommended dietary intakes for omega-6 and omega-3 fatty acids. *J Am Coll Nutr*. 1999; 18: 487-489.
View in (Google Scholar) (CrossRef)

21. Willatts, P., Forsyth, J. S., DiModugno, M. K., Varma, S., & Colvin, M. (1998). Effect of long-chain polyunsaturated fatty acids in infant formula on problem solving at 10 months of age. *The Lancet*, *352*(9129), 688-691.
View in (Google Scholar) (CrossRef)

22. Mataram, I. K. A., Laraeni, Y., & Agustini, N. P. (2017). Formula Kahiguru High Protein for Making of Food Supplement as Elimination Stunting. *International Journal of Life Sciences (IJLS)*, *1*(3), 14-27. View in (Google Scholar) (CrossRef)

23. Kusumayanti, G. D., & Dewantari, N. M. (2017). The Influence of Low Purine Diet and Physical Activity on Changing of Uric Acid Levels in Hyperuricemia. *International Journal of Health Sciences (IJHS)*, *1*(3), 1-9. View in (Google Scholar) (CrossRef)

24. Saxena, A. (2017). The Impact of Nutrition on the Overall Quality of Life Adolescent Girls are Living Across the City of Kota. *International Journal of Life Sciences (IJLS)*, *1*(1), 40-48. View in (Google Scholar) (CrossRef)

25. Puryana, I. G. P. S., & Antarini, A. A. N. (2018). Nutritional Content and Juleh Amino Acid Profile. *International Journal of Health Sciences (IJHS)*, *2*(1), 1-10. View in (Google Scholar) (CrossRef)

Biography of Authors

dr. Ni Putu Eka Suwitri was born on August 28th, 1986. She graduated her bachelor degree in Resident in Department of Pediatrics, Medical Faculty, Udayana University
Email: ekasuwitri86@yahoo.com

Dr. dr. I Gusti Lanang Sidiartha, Sp.A (K) was born on June 10th, 1962 in Karangasem. His position is the Head of Division Nutrition and Metabolic Diseases Department of Pediatrics, Medical Faculty, Udayana University. He as well as a Consultant of Nutrition and Metabolic Diseases (2011). His revious publication: (1) Sidiartha L, Bakta I, Wiryana I, Sutirtayasa I, Sjarif D. 2017. Eicosapentaenoic acid and docosahexaenoic acid in fish oil capsule. (2) Supplementation in obese children decreses serum interleukin-6 and hepcidin and improves iron status. Bali Med J, 6(1):97-101. (3) Daisy S, Dyah KW, Sidiartha IGL, Suparyata IB, Hartawan NB. 2017. Prevalence and association of cost and hospital malnutrition in Pediatric Intensive Care Unit Sanglah Hospital during 2015. Crit Care Shock, 20:10-16. (4) Cempaka PMVP, Sidiartha IGL. 2017. Waist circumference and insulin levels in obese children. Paediatr Indones, 57:194-7. (5) Paryati PV, Sidiartha IGL, Windiani IGAT, Adnyana IGANS. 2017. Quality of life among obese and non-obese early adolescents. Paediatr Indones, 57:216-22. *Email: lanangsidiartha@yahoo.com*