The impact of vitamin A fortified vegetable oil on vitamin A status of children under five years of age: A cohort study

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Sudikno[1], Sandjaja[1], Idrus Jus'at[2]

[1]Research and Development Center for Public Health Efforts, National Institute of Health and Research Department, Ministry of Health, Jakarta, Indonesia
[2]Faculty of Health Sciences, Esa Unggul University, Jakarta, Indonesia

Corresponding adress: Sudikno
Email: onkidus@gmail.com

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Abstrak

Latar belakang*: Defisiensi vitamin A sub-klinis dan anemia merupakan masalah gizi utama di Indonesia. Meski pemerintah telah melaksanakan program distribusi kapsul vitamin A, masih ada sepertiga anak yang tidak mendapatkan distribusi vitamin A. Penelitian ini bertujuan untuk mengukur efektivitas fortifikasi vitamin A pada minyak goreng tidak bermerek di antara kohort anak-anak keluarga miskin berusia 6-59 bulan di dua kabupaten di Indonesia sebelum mendapat fortifikasi vitamin A dalam minyak goreng.*

Metode*: Jumlah sampel sebanyak 126 anak. Darah vena diambil oleh phlebotomist terlatih. Serum retinol dan hemoglobin diukur pada awal sebelum fortifikasi minyak goreng dan 12 bulan setelah intervensi. Tidak ada intervensi dari tim peneliti mengenai distribusi dan pembelian minyak goreng, karena minyak goreng didistribusikan dan dijual melalui mekanisme pasar yang ada. Enumerator terlatih mengumpulkan variabel sosio-demografi. Mereka juga mengumpulkan recall makanan 24 jam dan kuesioner frekuensi makanan untuk mengukur asupan nutrisi pada awal dan akhir penelitian.*

Hasil*: Serum retinol meningkat secara signifikan sebesar 5,07, 6,82, 6,01 µg / dL pada anak usia 6-11, 12-23, dan 24-59 bulan. Hemoglobin meningkat sebesar 0,13 (p> 0,05), 0,56 (p <0,05), 0,81 g / dL (p <0,05) pada anak usia 6-11, 12-35, 36-59 bulan.*

Kesimpulan*: Fortifikasi vitamin A dalam minyak goreng secara bermakna meningkatkan serum retinol pada balita di semua kelompok umur dan hemoglobin hanya pada kelompok usia 12 bulan ke atas.* ***(Health Science Journal of Indonesia 2017;8(2):102-10)***

Kata kunci*: defisiensi vitamin A, fortifikasi vitamin A, minyak goreng*

Abstract

Introduction: Sub-clinical vitamin A deficiency (VAD) and anemia remain major nutritional problem in Indonesia. Although the government has implemented distribution of vitamin A capsules (VAC), there are one third of children missed VAC distribution. This study aimed to measure the effectiveness of vitamin A fortification in unbranded cooking oil among cohort of 6-59-month-old children of poor families in 2 districts in Indonesia prior mandatory vitamin A fortification in cooking oil.

Methods: Total number of samples were 126 children. Venous blood was drawn by trained phlebotomist. Serum retinol and hemoglobin were measured by HPLC and hemoque respectively at baseline just before cooking oil fortification and 12 months after at endline. There was not any intervention from the study team on distribution and purchase of fortified cooking oil by the families, because cooking oil was distributed and sold through exsisting market mechanism. Enumerators collected socio-demographic variables. They also collected 24-hr dietary recall and food frequency questionnaires to measure nutrient intakes at base- and endline.

Results: Serum retinol significantly increased by 5.07, 6.82, 6.01 µg/dL in 6-11, 12-23, and 24-59 month-old children respectively. Hemoglobin increased by 0.13 (p>0.05) , 0.56 (p<0.05), 0.81 g/dL (p<0.05) in 6-11, 12-35, 36-59 month-old children respectively.

Conclusions: Vitamin A fortification in cooking oil significantly improved serum retinol in underfive children in all age groups and hemoglobin only in older age groups. ***(Health Science Journal of Indonesia 2017;8(2):102-10)***

Keywords: vitamin A deficiency, anemia, vitamin A fortification, cooking oil

One of the major nutrition problems among poor households is vitamin A deficiency (VAD), especially in low and middle-income countries including Indonesia.[1] VAD has been shown to have a negative consequence on several body functions, which leads to decreasing health status among infants, young children, and pregnant women. Xerophthalmia is one form of severe vitamin A deficiencies and it is the main cause of night blindness among children around the globe.[2] Moreover, vitamin A deficiency has also been shown to be associated with an increase of children morbidity and mortality.[3]

The latest nationwide survey conducted in 1992 in which only 4 provinces where sub-clinical VAD were available.[4] (Ref). Results of the survey showed that based on subclinical indicator (serum retinol <20µg/dL), about 50 percent of children under five was suffering from VAD.[4] Furthermore, study on micronutrient deficiencies in 8 provinces in 2006 revealed that the prevalence of sub-clinical VAD was 11.36 percent (range 8.7 – 16.3%).[5]

The main causes of VAD, among others, is lack of vitamin A intake especially from carotene and vitamin A food sources, vitamin A malabsorption and other metabolic disturbances.[1] WHO has recommended vitamin A supplementation for infants age 6-11 months and children 12-59 months are 30 mg and 60 mg retinol twice a year, respectively.[6] Recent nationwide surveys have demonstrated an increased in coverage of vitamin A capsule distribution from 71.5 percent in 2007 to 75.5 percent in 2013.[7,8] However, the achievement has not yet reached the national standard of coverageof 90 percent coverage.[9] With the current coverage, it means that more than 5 million children 6-59-month-old missed vitamin A capsule (VAC) distribution. The coverage of vitamin A capsule was wide among district from 5.3 to 100 percent[7] and among province from 52.3 to 89.2 percent.[8] Insufficient intake of food rich in vitamin A or β-carotene contribute to this problem. A study of children 6-59-month-old showed that the mean daily intake of vitamin A was only contributed 39 to 87 percent of recommended dietary allowances (RDA)[10].

It has been stated elsewhere, there are several programs to control vitamin A deficiency, namely: food diversification, vitamin A supplementation, and food fortification.[11] Fortification of unbranded vegetable oil with vitamin A is considered as potential alternative to be executed since more than 80 percent of Indonesian population in all socio-economic strata and ethnics consumed unbranded vegetable oil daily.[12,13] Therefore, Indonesia planned to launch mandatory vitamin A fortification of unbranded cooking oil. There have been several activities and indepth studies by Ministry of Health, Ministry of Trade and Industry, Board of Food and Drug, Universities, and *Koalisi Fortifikasi Indonesia* (KFI), a non-government organization to prepare for the fortification since 2005. They includes appropriate food vehicles for fortification, level of daily cooking oil consumption, appropriate dose of vitamin A content in cooking oil, efficacy study of fortified cooking oil in Makassar, methods of fortification in big cooking oil industries, decrease of vitamin A content during transportation from the industries to the consumers, decrease of vitamin A content for cooking, and revision of Indonesian standard of cooking oil.[14,15,16]

Prior to the implementation of cooking oil fortification with vitamin A, an effectiveness study was conducted in two districts in West Java, Indonesia.[14] The aims were to measure the the improvement of serum retinol before and 12 months later after fortification in several age grups, namely babies 6-11, children 12-23, 24-59-month-old, school-age children 5-9-year-old, women of early reproductive age 15-35-year-old, and lactating mothers. The findings of the study revealed that there was significant improvement of serum retinol among all groups with the mean range of improvement from 3.8 to 8.1 µg/dL, except children 12-23-month-old (0.7 µg/dL, p=0.529), and children 24-59-month-old (2.3 µg/dL, p=0.059). The findings of not significant improvement could be attributed to samples included in the study was cross-sectional design for base- and endline. This means that there were additional children underfives at endline for the respective age groups. On the other hand, samples for school-age and women of reproductive age were the same samples both in baseline and endline. Therefore, other confoundings might interfere the results. Therefore, there is a need to analyse whether no significant result in children below 60 month old is due to additional new samples participated at the endline study where confounding factors may interfere the result. In order to do so, only those children participated both at base- and endline study to be analized.

Previous studies found that supplementation of vitamin A capsule not only improved serum retinol but also significantly improved hemoglobin status. The studies proved that vitamin A enhanced erythropoesis.[17] The main objective of this study was to evaluate the impact of fortified unbranded vegetable oil (UVO) with vitamin A on vitamin A serum among young children using the same samples at base- and endline data.

METHODS

Study Areas

This study was part of a pilot research on 'The evaluation of fortified unbranded vegetable oil with vitamin A', partly funded by National Institute of Health Research and Development (NIHRD), Ministry of Health, Indonesia, in 2011 (baseline) and KFI-GAIN, in 2012 (endline). The design and main result of the study was published elsewhere.[14] The subjects of the study were cohort children of under five years of age in Tasikmalaya and Ciamis districts, West Java. There were 4 peri-urban sub-districts selected randomly from each district. From each sub-district, 3 villages were selected randomly. There were 24 villages in total for this study.

The difference in the analysis of this study and the main result is on the subjects included in the analysis. Only sub-sample of those children participated at base- and endline study is included in the analysis as shown in Diagram 1.

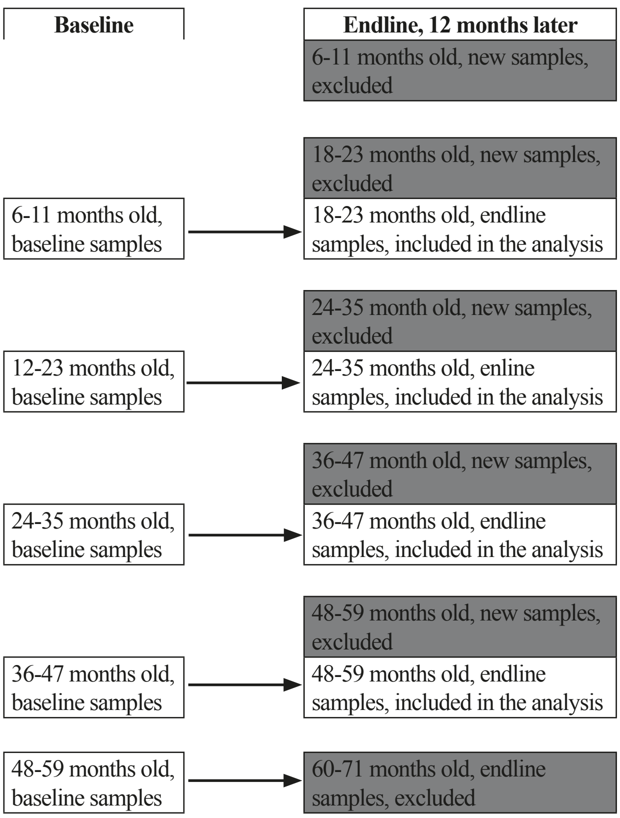

Diagram 1. Selection of sub-sample for cohort analysis

Fortified Oil

Fortification of unbranded vegetable oil was conducted by one of the biggest vegetable oil producer located in South Sulawesi.[18] This company added retinyl palmitate premix in the factory. The dose was set to be 45 IU retinol/g (13.6 mg retinol/kg unbranded vegetable oil (UVO) in accordance with Nasional Standard of Indonesia for unbranded red palm cooking oil. Fortified UVO was distributed and sold by existing market mechanism without any intervention from the study team. The fortified cooking oil was shipped to main distributors in West Java. Then, cooking oil was transported in tank trucks to oil distributors in some districts. The vegetable oil at district's distributor was put in drum (200 L) and resold to sub-districts' distributor. Food stalls at villages bought the oil from sub-districts' distributor to be resold in a small plastic bags (100 ml, 250 ml, and 500 ml) to consumers/households.[13,14]

Samples

The subjects for this study were young children aged 6-59 months from poor households in those 24 selected peri-urban villages. The definition of poor household was based on the availability of valid family poverty card. Only households that possessed this card were selected; the reason behind this selection was that these households were likely to be at increased risk for vitamin A deficiency or anemia and consumed of unbranded cooking oil. Apparently healthy young children decided by physical examination by community health center's physician, not suffering serious illnesses, not severely anemic and willing to participate in the study were recruited. The parents were asked to sign informed consent. The total number of samples at baseline was 890 children. This paper includes 126 young children with a complete pair data set at baseline and endline, 60, 40, and 26 pair data for age 6-11, 12-23, and 26 month-old respectively. By using alpha level (type-1 error) 0.10, the power is 96.6, 88.3, 73.9 and 99.8 for the age of 6-11, 12-23, 24-59, and total 6-59 month old respectively.

Data Collection

The data were collected using validated questionnaires by well-trained nutritionists. The training of enumerators was conducted in three consecutive days. The materials conveyed was sampling technique, understanding the content of questionnaires, anthropometric measurement, field organization, schedule of data collection, group dynamics to improve cooperation among enumerators. There were two field coordinators for each district to make sure all data collection executed properly in accordance with study protocol and schedule. Each enumerator checked the completeness of questionnaire and rechecked by field coordinator before data entry.

Blood Drawing

The blood was drawn from *vena mediana cubiti* by trained phlebotomists from a reputable lab "P". The blood was then divided into two parts, namely EDTA blood in one tube and plain (non-anticoagulen) blood in other tube. The plain blood was then centrifuged to get serum. Two 1.5 ml vials were used to place 0.5 ml serum. These serums were kept in cool box -4^{0}C and transported to a laboratory to be kept in a special refrigerator -80^{0}C before analysis was performed.

Measurement of Serum Retinol and Hemoglobin

Young children were called suffering from anemia when their hemoglobin level was below 110 g/L[19] and suffering from vitamin A deficiency when retinol serum is less than 20 mg/dl.[20]

We measure hemoglobin level using *Hemocue^{TM} portable* dan *hemocuvettes* (Hemocue, Aangelsborg, Sweden). The measurement was conducted directly in the field; the result was recorded in a prepared form for each subject. The serum was kept in cool box -20^{0}C, transported to the laboratory in Jakarta and stored in a refrigerator with temperature -80^{0}C before measurement is performed. The laboratory was accredited at national and international level for serum retinol analysis.

Measurement of Serum Retinol

Serum retinol was measured using high-performance liquid chromatography (HPLC). Serum was extracted with sodium dodecyl sulphate (SDS) and ethanol absolute then mixed thoroughly about 1 minute until it became homogen. We added heptane plus butylated hydroxyl toluene (BHT) and mixed with vortex in 1 minute. The solution was centrifuged about 10 minutes in 2000 RPM then result a clear solution and a little precipitation. A clear solution was then separated and steamed using N2 until dry. We then added mobile phase solvent HPLC and mix with vortex for 45 minutes. The solution was then transported to *vial insert* and ready to be measured with HPLC. We compared the curve of the sample with standard curve for serum retinol.

Dietary Consumption/ Intake

Food intake was collected by using 24-hour dietary recall method for two consecutive days. The enumerator interviewed the mother or child care-giver to obtain daily food intake of the children. Some foods were commercially prepared or processed food bought from food-stalls around the village. We bought those foods to be measured by food scale and get the ingredients and converted its energy and nutrients content based on Indonesian food composition table.[21] This effort was done in order to minimize error in the estimation of food intake from local street food frequently consumed by the samples.

Data Processing

All the collected data was coded in accordance with prepared codebook. We did double entry data and rechecked the completeness and consistency of all the information entered. When incomplete information was found, the field coordinator and enumerator went back to household to fulfil the missing data. During data processing, frequency tables and cross-tabulation between variables were analyzed for nominal and ordinal data, and measurement of central tendency was analyzed for continuous variabels to know data consistency check.

Data Analyses

The secondary data used for this analysis were only for pair data of the same children age 6-59-month-old at baseline and endline. Since this paper only include pair children available at base- and endline study as a cohort study, additional children at endline were excluded from the analysis since there were no data at baseline as shown in Diagram 1. We did univariate analyses to study the behavior of each variable and compute the prevalence of anemia and vitamin A deficiency. Paired t-test was employed to evaluate the effectiveness of fortification of unbranded vegetable oil with vitamin A on hemoglobin and serum retinol among young children.

Ethical Clearance

The study was approved by Ethical Committee of Health Research of NIHRD number KE.01.05/EC/262/2011 dated back May 3, 2011.

RESULTS

In general, age of the parents were 30-39 years old. About half of them were completed elementary school (father 54%; mother 48%). In addition, more than half of the fathers worked as unskilled blue collar labor in agricultural sector (64%) and about 90 percent of the mothers were housewives (Table 1).

At the baseline, almost half of young children were at the age of 6-11 months (Table 2). There were equal size of children by sex and less than half were the first child. There were about 6.5 percent low birth weight (LBW) children (only 2 parents has no record of their baby's birth weight). About 98.4 percent of children have received vitamin A capsule (VAC) in the last 6 months.

Tabel 1. Parental Characteristics

Characteristics	Father		Mother	
	n	%	n	%
Age (years)				
- 20-29	20	15,9	49	38,9
- 30-39	63	50,0	59	46,8
- 40-49	31	24,6	17	13,5
- 50-59	10	7,9	1	0,8
- >=60	2	1,6	-	-
Education				
- No schooling	4	3,2	4	3,2
- Elementary School	68	54,0	61	48,4
- Junior High School	33	26,1	41	32,5
- Senior High School	21	16,7	18	14,3
- Higher education	-	-	2	1,6
Occupation				
- Civil Servant	2	1,6	-	-
- Private Servant	3	2.4	3	2,4
- Trader	34	27,0	5	4,0
- Services	4	3,2	1	0,8
- Farmer	2	1,6	-	-
- Unskilled labor	81	64,1	4	3,2
- Housewife	-	-	113	89,6
Total	126	100	126	100

Tabel 2. Characteristics of Young Children

Characteristics	n	%
Age (months)		
- 6-11	60	47,6
- 12-23	40	31,7
- 24-59	26	20,7
Gender		
- Boys	61	48,4
- Girls	65	51,6
Child number		
- 1	45	35,7
- >=2	81	64,3
Low Birth Weight		
- Yes	8	6.3
- No	116	92.1
- Missing	2	1.6
Received VAC in the last 6 months		
- Yes	121	96.0
- Never	2	
- Missing	3	2.4
Total	126	100

As displayed in Table 3, the average intake of unbranded vegetable oil among infants aged 6-11mos has increased from 1.89±0.65 g in 2011 to 15.14±1.29 g/d in 2012, the highest increase compared to the two older groups because children ate a more variety of foods containing cooking oil with increasing age. Levels of energy, protein, fat intakes in 2011 and 2012 were increasing insignificantly, however there were still below recommended dietary allowances. Table 3 showed that there were significant difference of most nutrient intakes. However, by using percent RDA for older age group 1-3 year-old for the endline in 2012 since the age of the children become 18-23 month-old, there were no significant difference for nutrient intakes.

Tabel 3. Dietary and Nutrient Intakes of Young Children 6-11 months at baseline (2011) and after one year introduction of fortified cooking oil (2012)

Consumption/Intake	2011		2012		Mean diff [95% CI]	p
	n	Mean±SE	n	Mean±SE		
Vegetable Oil (g/d)	60	1,89±0,65	60	15,14±1,29	13,25 [10,26-16,24]	0,000
Energy(kcal)	60	296,4±31,1	60	579,9±25,1	283,5 [202,1-364,9]	0,000
Protein (g)	60	9,8±1,1	60	19,4±0,9	9,6 [6,5-12,7]	0,000
Animal protein (g)	60	5,7±0,8	60	10,9±0,9	5,1 [2,4-7.8]	0,000
Fats (g)	60	7,8±1,3	60	22,5±1,2	14,7 [10,9-18,4]	0,000
Vitamin A (mcg)	60	296,13±57,22	60	428,65±109,05	132,52 [110,89-375,94]	0,280
Animal Vitamin A (mcg)	60	142,83±52,05	60	195,26±109,14	52,43 [-300,00-195,13]	0,673
Vitamin C (mg)	60	8,35±1,52	60	9,07±1,07	0,71 [-2,55-3,99]	0,663
Fe (mg)	60	2,72±0,49	60	4,28±0,59	1,56 [0,17-2,94]	0,028

Notes:
RDA energy for 0-6 mos= 550 kcal, 7-11 mos= 725 kcal, 1-3 years= 1125 kcal
RDA protein for 0-6 mos= 12 g, 7-11 mos= 18 g, 1-3 years= 26 g
RDA fat for 0-6 mos= 34 g, 7-11 mos= 36 g, 1-3 years= 44 g
RDA vitamin A for 0-6 mos= 375 mcg, 7-11 mos= 400 mcg, 1-3 years= 400 mcg
RDA vitamin C for 0-6 mos= 40 mg, 7-11 mos= 50 mg, 1-3 years= 40 mg
RDA iron for 0-6 mos= - mg, 7-11 mos= 7 mg, 1-3 years= 8 mg

Average consumption of unbranded vegetable oil among children aged 12-23 mos was increased significantly (p<0.05) from 12.3±1.7 g/d in 2011 to 20.0±1.7 g/d in 2012 (Table 4). While, the average intakes of energy, protein, and fats in both years were still below the recommended dietary allowances. There were insignifantly difference intakes of energy, protein, fats, vitamin A and vitamin C, and iron between those two years (p>0.05).

As displayed in Table 5, the average consumption of unbranded vegetable oil among children 24-59 months was not different between 2011 and 2012 (p>0.05). Similar condition to younger group of children, the average consumption of energy, protein, fats, vitamin A, vitamin C, and iron in this group in 2012 was indifference from those of 2011 (p>0.05).

Prevalence of Vitamin A Deficiency

By using WHO criteria cut-off point to define vitamin A deficiency oft <20 mg/dl[24], there was an overall decrease significantly in the prevalence of vitamin A deficiency among children 6-59 months (Table 6). However, stratified by age group it shown that the significant decrease was found only among children aged 12-23 months (p<0.05), while the other two groups was insignificantly decreased (p>0.05).

Tabel 4. Dietary and Nutrients Intake of Young Children 12-23 Months at baseline (2011) and after one year introduction of fortified cooking oil (2012)

Intake	2011		2012		Mean diff [95% CI]	p
	n	Mean±SE	n	Mean±SE		
Vegetable oil (g/d)	40	12,34±1,74	40	20,04±1,68	7,70 [3,28-12,12]	0,001
Energy (kcal)	40	627,1±69,7	40	764,9±33,4	137,7 [-5,9-281,4]	0,060
Protein (g)	40	20,9±2,7	40	25,1±1,3	4,2 [-1,2-9,7]	0,128
Animal Protein (g)	40	11,5±2,2	40	14,2±1,1	2,7 [1,8-7,3]	0,239
Lemak (g)	40	24,6±2,9	40	28,6±1,6	3,9 [-2,2-10,1]	0,205
Vitamin A (mcg)	40	547,01±92,07	40	591,80±114,54	44,78 [-237,88-327,45]	0,750
Animal Vitamin A (mcg)	40	124,70±42,85	40	231,35±101,24	106,65 [-112,18-325,48]	0,330
Vitamin C (mg)	40	15,77±4,37	40	12,22±1,72	-3,55 [-12,70-5,60]	0,438
Fe (mg)	40	6,19±1,61	40	5,50±0,96	-0,69 [-3,76-2,36]	0,648

Note:
RDA energy for 1-3 years= 1125 kcal, 4-6 years= 1600 kcal
RDA protein for 1-3 years= 26 g, 4-6 years= 35 g
RDA fa for 1-3 years= 44 g, 4-6 years= 62 g
RDA vitamin A for 1-3 years= 400 mcg, 4-6 years= 450 mcg
RDA vitamin C for 1-3 years= 40 mg, 4-6 years= 45 mg
RDA iron for 1-3 years= 8 mg, 4-6 years= 9 mg

Tabel 5. Dietary and Nutrients Intake of Young Children 24-59 months at baseline (2011) and after one year introduction of fortified cooking oil (2012)

	2011		2012		Mean diff [95% CI]	p
	n	Mean±SE	n	Mean±SE		
Vegetable oil (g/d)	26	25,89±2,96	26	25,17±2,78	-0,72 [-9,70-8,24]	0,869
Energi (kval)	26	1028,5±77,4	26	940,1±56,8	-88,4 [-297,1-120,2]	0,391
Protein (g)	26	29,2±2,4	26	29,3±2,4	0,1 [-7,0-7,2]	0,971
Animal Protein (g)	26	14,5±2,1	26	15,3±1,9	0,8 [-5,4-7,1]	0,789
Fats (g)	26	39,0±3,3	26	35,4±2,7	-3,6 [-13,4-6,2]	0,455
Vitamin A (mcg)	26	910,90±146,08	26	565,73±66,32	-345,17 [-712,22-21,87]	0,064
Animal Vitamin A (mcg)	26	218,23±66,21	26	171,03±36,89	-47,19 [-213,92-119,53]	0,565
Vitamin C (mg)	26	24,15±5,29	26	12,67±2,08	-11,48 [-23,38-0,42]	0,058
Fe (mg)	26	9,33±2,85	26	5,66±1,05	-3,67 [-10,00-2,66]	0,244

Tabel 6. Prevalence of Vitamin A Deficiency among Young Children at baseline (2011) and after one year introduction of fortified cooking oil (2012)

Age group	2011		2012		p
	n	%	n	%	
6-11 months	60	18,3	60	10,0	0,133
12-23 months	40	20,0	40	0,0	0,003
24-59 months	26	19,2	26	3,8	0,103
6-59 months	126	19,0	126	5,6	0,003

Tabel 7. Prevalence of Iron Deficiency Anemia in Young Children at baseline (2011) and after one year introduction of fortified cooking oil (2012)

Age groups	2011		2012		p
	n	%	n	%	
6-11 months	60	53,3	60	41,7	0,180
12-23 months	40	45,0	40	20,0	0,003
24-59 months	26	19,2	26	11,5	0,327
6-59 months	126	43,7	126	28,6	0,001

Prevalence of Iron Deficiency Anemia

By using WHO cut-off point of anemia[25], the overall prevalence of iron deficiency anemia among young children was about 43.7 percent, and it was declining significantly in 2012 (28.6%). Such a decreased mainly among children aged 12-23 months ($p<0.05$), while in other groups there were a tendency of decreasing in the prevalence, though it is not statistically significant.

The Difference of Serum Vitamin A and Hemoglobin in 2011 and 2012

In total, serum retinol was increased significantly among these three groups ($p<0.05$). Among children aged 6-11, 12-23, 24-59 months, serum retinol was increased from 29.6±1.6, 27,9±1,8, 29,4±1,1 g/dl in 2011 to 34.6±1.4, 34,7±1,4, 35,2±0,9 g/dl in 2012, respectively. Eventhough, there was insignificantly increased in children aged 6-11 months the hemoglobin level among children aged 12-23 and 24-59 were increased significantly from 11.0±0.23, 11.9±0.3 in 2011 to 11.6±0.2, 12.7±0.3 mg/L.

DISCUSSIONS

This study found that the average intake of energy, protein, fats, vitamin A, vitamin C and iron in both years of base- and endline were below the recommended dietary allowances. There were similar in all nutrient intakes and also vegetable oil intake in the oldest age group of 24-59 mos, Or in other word, they have a similar intake patterns A study by Sumedi et al[22] found that higher variety of foods intake in this age group compared to the younger age group. Lack of vitamin A intake from daily food consumption among these age groups was in accordance with other study.[23] Increase of dietary intake of most nutrients and vegetable oil intake except for vitamin A and iron intake found in the youngest age group of 6-11 mos. It is understandable that the increasing intake due to increasing age of 6-11 mos in 2011 to 18-23 mos in 2012. Compared with age of 12-23 mos at baseline nutrient intakes were similar (endline of 6-11 mos = 15.14 g/d in 2011 compare to 12.34 g/d baseline of 12-23 mos in 2011). Unbranded vegetable oil consumption among young children age 6-11 and 12-23 months were increased. Complementary feeding for infants aged 6-11 months and foods for children aged 12-23 months are always having limited amount of vegetable oil. Increasing age, it is always followed by diversity

Tabel 8. The Difference of Serum Retinol and Hemoglobin among Young Children at baseline (2011) and after one year introduction of fortified cooking oil (2012)

Variables	2011		2012		Mean diff [95% CI]	Sig. (2-tailed)
	n	Mean±SE	n	Mean±SE		
6-11 months						
Serum Vitamin A (µg/dL)	60	29,58±1,57	60	34,65±1,35	5,07 [1,26-8,88]	0,010
Hemoglobin (g/dL)	60	11,00±0,15	60	11,13±0,20	0,13 [-0,36-0,63]	0,596
12-23 months						
Serum Vitamin A (µg/dL)	40	27,91±1,80	40	34,73±1,40	6,82 [2,62-11,01]	0,002
Hemoglobin (g/dL)	40	11,00±0,23	40	11,56±0,21	0,56 [0,06-1,06]	0,028
24-59 months						
Serum Vitamin A (µg/dL)	26	31,11±2,57	26	37,13±2,14	6,01 [0,50-11,52]	0,034
Hemoglobin (g/dL)	26	11,88±0,25	26	12,70±0,28	0,81 [0,22-1,41]	0,009
6-59 months						
Serum Vitamin A (µg/dL)	126	29,36±1,07	126	35,19±0,89	5,82 [3,36-8,27]	0.000
Hemoglobin (g/dL)	126	11,18±0,12	126	11,59±0,14	0,41 [0,10-0,71]	0,009

of foods consumed by children. However, when the children getting older, the amount of vegetable oil consumed daily is relatively constant and also similar. It is understandable level of vegetable oil intake among children 6-11 months on average is 1,9±0,7 g/d since the ingredients of their complementary feeding was less contents of vegetable oil. When they grown up, their daily foods consumed contained more vegetable oil. Therefore, consumption of vitamin A from fortified vegetable was also increase. Another study showed vitamin A content in fortified vegetable oil contributed 25.9 to 42.1 percent RDA of daily intake of children 12-59 mos.[24]

This study has demonstrated the effectiveness of fortification unbranded vegetable oil with vitamin A to increase the overall serum retinol and hemoglobin level. Stratified by age groups revealed that serum vitamin A level was significantly increase in all age groups, while hemoglobin level failed to show significant improvement in the youngest and oldest age groups.

Achadi's et al. found a median of 130 g/d UVO consumed by a household with 5 family members, so it is possible the average consumption of unbranded vegetable oil per person is about 26 g/d. The present study displayed retinyl palmitate content in unbranded vegetable oil is about 43.6±2.5 IU/g at factory, 28.3±7.7 IU/g at district's distributor, 25.7±10.5 IU/g at food stall in the village, and 28.5+12.0 at households.[23]

An important finding of this study is fortification of unbranded vegetable oil with vitamin A decreased the prevalence of vitamin A deficiency in all age groups. The prevalence of vitamin A deficiency among children age 6-59 was 19.0% in 2011 and decrease to 5.6% in 2012. In addition, a reduction of the prevalence of iron deficiency anemia is found from 43.7% in 2011 to 28.6% in 2012.

At the baseline, the average of serum retinol among children age 6-11, 12-23, and 24-59 months were 29,58±1,57 μg/dL, 27,91±1,80 μg/dL, dan 29,36±1,07 μg/dL. This finding is relatively similar with Sandjaja's [24] finding. Slight difference might be due to difference sample size. The main objective of this study was to measure the improvement of vitamin A status. It was shown that vitamin A status was significantly improved. However, a lot of children were excluded from this analysis because at endline in 2012 were not included in the baseline. Only 126 children out of 890 children included in the analysis. This limitation may reduce the power of the test. Backward calculation showed that using alpha error 10 percent, the power of test was 96.56, 88.30 and 73.89 percent for children 6-11, 12-23, and 24-59 mos respectively. The overall power of the test for 6-59 mos remain high as 99.89 percent.

We confirmed an increase serum retinol in all age group and hemoglobin level in 12-23 and 24-59 age groups after one year intervention of fortification unbranded vegetable oil with vitamin A in the form of retinyl palmitate ($p<0.05$).

Fortification of unbranded vegetable oil with vitamin A is one strategie that can be implemented to handle vitamin A in addition to vitamin A supplementation and food diversification. Result from vitamin A intervention study by Tanumihardjo et al. (2004) showed an increase of both vitamin A status and hemoglobin level.[25]

In conclusion, a one year fortification of vegetable oil with vitamin A increases serum retinol and hemoglobin of young children from poor families.

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