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# Effect of Feeding Street Foods Containing Coconut Palm Sugar Enriched with Red Palm Oil (RPO) on Serum Retinol Level and Nutritional Status of Elementary School Children

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**Abstract**

Coconut palm sugar enriched with red palm oil (RPO) which contained high pro-vitamin A was expected to contribute on nutritional status improvement, particularly vitamin A status. The main objective of this study was to analyze the efficacy of coconut palm sugar enriched with RPO on serum retinol level and nutritional status of elementary school children. The study was conducted in Elementary School 1 and Elementary School 2, village of Adisara, Jatilawang district, Banyumas regency. Single-blind randomized experimental design was used. Subjects aged 7-9 years were grouped into two categories: 1) the group of moderately malnourished students which accepted RPO palm sugar (RPO group) 2) the group of moderately malnourished students which accepted control palm sugar (control group). Both groups received coconut palm sugar-based foods for 45 days. Parameters observed were body weight, serum retinol level, nutritional status (WAZ) and morbidity.

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The results showed that RPO group had higher serum retinol level improvement, that was 17.80±13.24 µg/dL ($p<0.05$) and there was a nutritional status improvement indicated by the increase in Z-score value (WAZ) by 0.10 and weight gain by 0.5 kg ($p<0.05$). Coconut palm sugar enriched with RPO, as a source of pro-vitamin A, was potential as an alternative food to combat vitamin A deficiency (VAD) and improve nutritional status.

***Keywords:*** coconut palm sugar; RPO; pro-vitamin A; serum retinol; nutritional status.

## 1. Introduction

Based on the results of a national survey of micronutrients in 2009, there were still 0.13% (cut-off point of 5%) cases of xeropthalmia, serum retinol index by 14.6% (cut-off point of 15%), and a decline in coverage of vitamin A supplementation nationally found in Indonesia [1]. From these data, it can be concluded that vitamin A deficiency (VAD) in Indonesia no longer becomes a public health problem because its prevalence is under the standard of International Vitamin A Consultative Group (IVACG). However, it does not guarantee that VAD will not arise in the coming years. Therefore, alternative efforts remain necessary to maintain this condition.

Utilization of red palm oil (RPO) as a source of pro-vitamin A in the production of coconut palm sugar is one of the breakthrough to provide a type of vitamin A-rich foods based on local potential, in an effort to alleviate the VAD. Indonesian palm oil potential is high, reaching 20.75 million tons per year, will ensure the continuity of availability of pro-vitamin A sources [2].

Several studies had examined the bioavailability of carotenoids, either in RPO or CPO, given directly or added in fruit juices and biscuits showed a positive effect on vitamin A status improvement based on the increase in serum retinol level [3,4,5].

Results of other studies also showed that the addition of RPO by 3 ml per liter of sap was sensory acceptable and contained 13.37 µg/g total carotene with 25.3% retention [6,7]. Furthermore, the results of previous study also showed that coconut palm sugar enriched with CPO or RPO given to mice for 4 days equivalent to 40 µg β-carotene/day could improve vitamin A status of the depleted mice up to above normal [8].

Children with moderate malnutrition had lower serum retinol level than children with better nutritional status [9]. Based on these descripitions, the study was conducted which aimed to assess the effect of feeding street foods containing coconut palm sugar enriched with RPO on the improvement of serum retinol level and the nutritional status of elementary school children with moderate malnutrition.

## 2. Material and Methods

### *2.1 Design, Location, and Time of Study*

Places of intervention were State Elementary School Adisara 1 and 2, Jatilawang District, Banyumas Regency. The location was chosen based on areas with high prevalence of protein-energy malnutrition (PEM) on

elementary school children with low socio-economic conditions.

Intervention study was conducted from May to June 2014. The design used was single-blind randomized controlled trial (RCT) pre-post study. Treatment in this study was feeding street foods containing RPO coconut palm sugar and street foods containing coconut palm sugar without RPO, for 45-day duration of intervention. Ethical clearance was obtained from the health research ethic committee of the Faculty of Public Health, Diponegoro University No. 310/EC/FKM/2013 dated December 27, 2013.

### *2.2 Research subjects*

Subjects in this study were elementary school children aged 7-9 years with low body weight or moderate malnutrition (-3 SD≤weight-for-age Z-score (WAZ)<-1.5 SD), parents of the subjects agreed to participate by signing the informed consent, as well as willing to comply with study procedures. Subjects were allocated into two (2) intervention groups named as RPO group (n=11) and control group (n=12). Administration of street foods was conducted on school break time (09.00 a.m.) so that all subjects were able to eat at the same time.

### *2.3 Type of Data and Method of Data Collection*

Primary data collected in this study were data of the subjects and their families. Subjects' data included gender, age, food consumption, body weight, morbidity, and serum retinol level. The data of subjects' families collected were the number of family members, education and occupation of the father, and family income. Subjects' data (except serum retinol and body weight) and family's socio-economic were collected through interviews with the childen and parents using questionnaires, morbidity was obtained through direct interview to the subjects, food consumption was obtained by food recall, and weight was measured by direct weighing while serum retinol level was determined from the analysis result by High Performance Liquid Chromatography (HPLC) method in integrated laboratory, Applied Technology Center of Health and Clinical Epidemiology, Department of Health Republic of Indonesia, Bogor. Compliance level in consuming the intervention food was obtained through observations by the teachers.

### *2.4 Data Processing and Analysis*

Data processing was performed using Microsoft Excel program and SPSS software version 16.0 for Windows. Subjects' characteristics and family's socio-economic data were analyzed by descriptive statistics. Comparative test was used to analyze the differences in weight, WAZ, serum retinol level and morbidity of the subjects between RPO group and control group; as well as to analyze the differences before and after the intervention.

Differences in serum retinol level and nutritional status of RPO and control groups, either at the beginning and end of the intervention, were analyzed by t-test. T-test was also used to determine the differences in the proportion of subjects' gender, number of family members, head of family's occupation and educational level, income level, and nutrient intake between RPO group and the control group. Paired sample t-test was used to determine the intervention effect on serum retinol level and nutritional status of the subjects before and after the intervention. If the p-value of test result was less than 0.05 (α=5%), then there was a significant difference

between the analyzed variables.

## 3. Results

### *3.1 Subjects' characteristics and Family's Socio-Economic Conditions*

Subjects' characteristics were age and gender. Meanwhile, socio-economic conditions of the family consisted of the number of family members, education and occupation of the head of the family (father), and income per capita. Subjects' characteristics and family's socio-economic conditions were presented in Table 1.

**Table 1:** Subjects' characteristics and family's socio-economic conditions

| Variables | P value |
|---|---|
| Gender | 0.068 |
| Number of family members | 0.034* |
| Father's educational level | 0.153 |
| Father's occupation | 0.345 |
| Family income | 0.053 |

*) $p<0.05$ = significantly different

Mean age of the subjects in RPO group was 8.17±0.56 years and in the control group was 9.21±0.22 years. It could be seen in Table 1 that most of the subjects in RPO group were female (63.63%) while most of the subjects in the control group were male (75%) but this result was not significantly different statistically. The majority of subjects in RPO group had medium family size with a proportion of 63.64% whereas most of the subjects (58.33%) in the control group had small family size. There was a significant difference in the family size category between both groups ($p=0.034$).

Based on educational level category, educational level of subjects' family heads mostly were only up to elementary or junior high school with a total percentage of 60.87%. Most of subjects' head of family in RPO group were junior and senior high school graduates (45.45% in each educational level) while the ones in the control group were mostly educated up to junior high school (75%). There were no significant differences in educational level of the head of the family between RPO and control groups ($p>0.05$).

It could be seen in Table 1 that 47.83% subjects' fathers worked as a merchant. The second sequence was a farmer/farm worker which amounted to 39.13%. Types of occupation on most subjects' family heads in RPO group were farmer/farm worker and merchant (36.36%). Most of the subjects' family heads in the control group worked as a merchant (58.33%) and 41.67% of them worked as a farmer/farm worker. There were no significant differences in type of occupation of the family head in RPO and control groups.

Data showed that there were more poor families than non-poor families in both groups in this study. Most of subjects' families in RPO group (72.72%) included in the poor category. As with the control group, most of

subjects' families (58.33%) were categorized as poor families. There were no significant differences in the category of income per capita per month in both groups ($p>0.05$).

### *3.2. Energy/Nutrient Intake and Contribution of the Intervention Food*

Intervention was given every day for 45 days in the form of street foods containing coconut palm sugar enriched with RPO and control sugar for comparison. Mean intakes of energy and nutrients of the subjects from the intervention food and daily intake were presented in Table 2.

**Table 2:** Mean intakes of energy and nutrients of the subjects from the intervention food and daily intake

| Energy/Nutrient | RPO group | | | | Control group | | | |
|---|---|---|---|---|---|---|---|---|
| | Intervention food | Daily intake | Total | % RDA | Intervention food | Daily intake | Total | % RDA |
| Energy (Kcal) | 200.63 | 875.01 | 1075.64 | 58.14 | 196.11 | 816.94 | 1013.05 | 54.76 |
| Protein (g) | 2.91 | 24.72 | 27.63 | 56.39 | 2.91 | 23.93 | 26.84 | 54.78 |
| Vitamin A (RE) | 125.24 | 135.70 | 260.94 | 52.19 | 3.23 | 117.65 | 120.88 | 24.18 |

Overall, daily energy and protein adequacy levels in RPO and control groups only met 50% RDA. On the other hand, vitamin A adequacy level in RPO group could meet 52.19% RDA and it was lower in the control group (only met 24.18% RDA).

### *3.3 Effect of Intervention on Body Weight*

Before the intervention, mean weight of the subjects in RPO group was 19.91±1.68 kg while mean weight in the control group was 22.33±1.53 kg. Intervention feeding in RPO group for 45 days significantly increased body weight of the subjects by 0.5 kg ($p<0.05$) while the body weight in the control group also increased by 0.17 kg but not significant ($p>0.05$). Weight changes in RPO and control groups were presented in Table 3.

**Table 3:** Mean weight gain (kg) of the subjects before and after intervention

| | RPO | Control | p-value |
|---|---|---|---|
| Before intervention | 19.91±1.68 | 22.33±1.53 | 0.002* |
| After intervention | 20.41±1.71 | 22.50±1.43 | 0.004* |
| p-value | 0.000* | 0.368 | |
| Changes | 0.50±0.32 | 0.17±0.62 | 0.167 |

*) $p<0.05$ = significantly different

### *3.4 Effect of Intervention on Nutritional Status (weight-for-age Z-score)*

The group given street foods using RPO sugar experienced an increase in their nutritional status which was indicated by the increase in WAZ value by 0.10±0.12. Meanwhile, there was a decrease in WAZ value by -0.02±0.2 in the control group. Changes in WAZ were in line with the increase in body weight in RPO group which were better than the control group. Mean increase in subjects' Z-score before and after the intervention was presented in Table 4.

**Table 4:** Mean increase in subjects' Z-score before and after intervention

| | RPO | Control | p-value |
|---|---|---|---|
| Before intervention | -1.78±0.41 | -1.77±0.54 | 0.959 |
| After intervention | 1.68±0.40 | -1.78±0.46 | 0.570 |
| p-value | 0.018* | 0.806 | |
| Changes | 0.10±0.12 | -0.02±0.21 | 0.113 |

*) $p<0.05$ = significantly different

### *3.5 Effect of Intervention on Serum Retinol Level*

Mean value of serum retinol level in RPO group before the intervention was 29.79±6.28 µg/dL while in the control group was 26.68±5.83 µg/dL. The result of comparative test between mean value of serum retinol level in RPO and control groups showed no significant difference ($p>0.05$). Mean serum retinol level in both groups improved after given the intervention food for 45 days in which it became 47.59±9.02 µg/dL in RPO group and 29.54±4.66 µg/dL in the control group. Serum retinol level in RPO group was significantly different ($p<0.05$) between before and after the intervention while there was no significant difference found in the control group (Table 5).

**Table 5:** Mean increase in serum retinol (µg/dL) of the subjects before and after intervention

| | RPO | Control | p-value |
|---|---|---|---|
| Before intervention | 29.79±6.28 | 26.68±5.83 | 0.255 |
| After intervention | 47.59±9.02 | 29.54±4.66 | 0.000* |
| p-value | 0.001* | 0.108 | |
| Changes | 17.80±13.24 | 2.86±5.07 | 0.004* |

*) $p<0.05$ = significantly different

### *3.6 Effect of Intervention on Morbidity*

Subjects in the RPO and control groups had low mean morbidity score before intervention. Mean score of morbidity in RPO group was 3.18 and 2.42 in the control group (Table 6).

**Table 6:** Mean morbidity score of the subjects before and after intervention

| | RPO | Control | p-value |
|---|---|---|---|
| Before intervention | 3.18+3.82 | 2.42+4.01 | 0.425 |
| After intervention | 0.45+1.04 | 0.00+0.00 | 0.131 |
| p-value | 0.042* | 0.042* | |
| Changes | 2.73 | 2.42 | |

*) $p<0.05$ = significantly different

There was no difference in morbidity score of the subjects between RPO and control groups statistically, either before or after the intervention ($p>0.05$). However, mean score of morbidity after the intervention decreased significantly in both treatment groups.

**4. Discussion**

Phases of study included the production of RPO and non-RPO coconut palm sugar, production of intervention food, and implementation of the intervention. Coconut palm sugar production was conducted in Ngudi Lestari coconut palm sugar industry, Kalisalak Village, Kebasen District, Banyumas Regency. First step in coconut palm sugar production was coconut sap cleansing. It was then heated to boiling, cooled, and refiltered using a filter cloth (Munyl Switzerland 500 mesh) to separate the impurities or fine dirt. At the defoaming stage, modification was made by replacing the use of vegetable oil with RPO in the amount of 30 ppm. The addition of RPO was done after reaching supersaturation phase. Heating was continued until the end point was reached ($118^0$C). Cooking process was stopped and continued with continous stirring (solidification stage) until the sugar mass turned into an opaque and then the molding was performed. The analysis showed that β-carotene in RPO sugar produced on an industrial scale was 29.36 µg/g with 64.55% retention.

The next phase was the production of intervention food. Street foods served for 45 days varied, namely mung bean extract, *nopia*, *biji salak* (sweet potato balls), *bubur mutiara*, and *bubur sumsum* (gruel). For example was the production of street foods made from mung bean extract. Ingredients used were mung bean and coconut palm sugar. Production procedures were as follows: mung beans were sorted and washed until clean, then soaked for 2 hours, boiled to rupture and stirred until dissolved. The beans were filtered and water was added, and then boiled until boiling, 15% coconut palm sugar was added, and lastly they were packaged in a 200 ml cup size.

A week before the implementation of intervention, students who became the subjects in this study were given anthelmintic. Anthelmintic given was Combantrin syrup at a dose of 10 ml/child. Baseline data were then collected, namely body weight, serum retinol level, morbidity, the characteristics of the subjects and their families. Consumption data were collected by the enumerators using 2x24-hour recall on school days and holiday. Street foods were given during school break time (09.00 a.m.) so that all subjects could consume the food at the same time. Teachers played a role in conditioning the subjects to consume the street foods together in the classroom and supervising them when they eat the street foods, as well as motivating the subjects to

always spend the provided foods. Compliance level of the subjects related to street food consumption was recorded by filling out a form by their teachers. Endline data were then collected at the end of intervention.

The amount of energy, protein, and vitamin A intakes would affect the growth and development of children. The contribution of energy, protein, and vitamin A from the intervention food for 45 days was proven to increase body weight of the subjects. This result was consistent with the previous study which showed that 2-week-intervention by providing coconut palm sugar enriched with RPO was able to improve the weight of the depleted mice by 3.54% [8]. Another study also showed that RPO administration which was substituted in 30% oil in diet formula for normal mice for 4 weeks could increase the weight up to 15.34 g [10]. This finding was likely related to the role of the 125.24 RE vitamin A addition per day acquired by RPO group. Weight gain was also occurred in the control group (increased by 0.17 kg) but it was not significant ($p>0.05$). It was likely due to energy and protein intakes from the intervention food which contributed to subjects' weight gain.

The contribution of energy, protein and vitamin A from the intervention food for 45 days also had an impact on the nutritional status of the subjects as indicated by the changes in WAZ value. This study was consistent with another study stating that RPO consumption led to better growth and development through nutrient retention effect [10]. Another study reported that RPO consumption in moderate level encouraged the efficient use of nutrients and improved immune function [11]. Furthermore, VAD could lead the changes in the integrity of intestinal epithelial cells where the intestinal villi cells underwent metaplasia that would have an impact on intestinal function abnormalities, including in the absorption of nutrients [12]. Vitamin A, β-carotene and vitamin E were cofactors in immune response [13]. Immune status improvement would improve the metabolic processess in the body, including the absorption and synthesis of nutrients which ultimately would result in better growth.

There was an increase in serum retinol level by 59.75% in moderate malnutrition group which was given street foods containing RPO coconut palm sugar for 45 days with 25.05% RDA of vitamin A level. This result was consistent with the previous study which showed that the use of RPO added in biscuits and given for 6 months to school children with 34% RDA β-carotene level was able to improve vitamin A status by increasing serum retinol amounted to 46.7% [14]. Previous study showed that the administration of 5 ml RPO per day in school children for a year managed to increase serum retinol level from 33.45 into 63.75 µg/dL (90.58%) [15]. In addition, another study showed that the administration of RPO equivalent to 90 mg β-carotene for 10 days in nursing mothers could increase serum retinol level up to 15.63% [16].

The decrease in morbidity score in RPO group tended to be higher (2.73) than the control group (2.42) although there was no significant difference statistically ($p=0.885$). This was presumably due to the intervention period which was still not enough to lower the morbidity score significantly. The decrease in morbidity score which tended to be higher in RPO group was allegedly due to the effect of intervention food, namely coconut palm sugar containing pro-vitamin A. Retinoic acid was one form of vitamin A which played a role in maintaining immune homeostasis by improving the function of Th1 and Th2 cells [17] so that adequate intake of vitamin A was able to expedite the humoral and cellular immunity in mucosa [18].

## 5. Conclusions

Feeding street foods made from coconut palm sugar rich in pro-vitamin A from red palm for 45 days significantly increased serum retinol level. There was a quite high increase in serum retinol level found in moderate malnutrition group which was given street foods using RPO coconut palm sugar, i.e. 17.80±13.24 µg/dL ($p<0.05$) after the intervention whereas the increase in the control group was only 2.86±5.07 µg/dL ($p>0.05$). There was a significant nutritional status improvement in RPO group, indicated by the increased WAZ value at 0.10 and weight gain of 0.5 kg ($p<0.05$). On the contrary, there was a decrease in WAZ value by -0.02 in the control group given supplementary food made with non-RPO sugar (control sugar).

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