β-Carotene Levels in Yellow Pumpkin (*Cucurbita moschata*) as an Enteral Substitution with Variation of Grinding Time Using a Blender

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Abstract. Nutritional support consists of two types, namely commercial enteral formula and blenderized. A local food ingredient with potential application as an enteral formula is referred to yellow pumpkin (*Cucurbita moschata*). Yellow pumpkin contains a source of carotenoids which play a significant role in forming pro-vitamin A. However, it is sensitive to heat. The study aimed to analyze β-Carotene levels in yellow pumpkin (Cucurbita moschata) as an enteral substitution with various grinding times using a blender. The study employed an experimental with a single-factor completely randomized design (CRD) with three variations of blending time (30, 60, and 90 s). The data was normal ($p \geq 0.05$), and the One-Way Anova test was subsequently conducted at a significant level of 95% for the statistical analysis. The β-carotene levels of the enteral with three blending times from the lowest time included 4.75 mcg/100 g, 4.32 mcg/100 g, and 4.11 mcg/100 g, which respectively had ($p = 0.00$). As the substitution of the enteral, the yellow pumpkin showed a higher level of β-carotene with variations of blending time of 30 s. The longer the blending time, the lower the impact of the β-carotene level.

Keywords: β-carotene · blending time · enteral · yellow pumpkin

1 Introduction

Patients who are hospitalized are a group at risk for malnutrition. The prevalence of patients at risk for malnutrition in hospitals shows significant results and increased continually from 2.5% in 2008 to 8.9% in 2018 [1, 2]. It requires proper nutritional care with oral or nutritional support such as enteral feeding [3]. Enteral nutrition is enteral feeding provided within 24–36 h after admission to the intensive care unit or 12 h after intubation and placement of mechanical ventilation [4].

Enteral nutrition is an effort to fulfill patients' nutritional demands and effectively improve the patient's quality of life and prevent malnutrition [3]. The food is recommended for a patient with appropriate nutritional status, yet it cannot fulfill 80% energy adequacy to prevent weight loss [5] and malnourished patients [6]. Thus, it can be provided to hospital patients or outpatients [7] using commercial products or blenderized

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tube feeding, commonly called hospital-made or homemade enteral formula. The foods can be administrated to patients to fulfill their nutritional demands [8, 9]. Blenderized enteral formula has been reported that it can shorten the length of stay of patients in the hospital, increase patient weight, cut hospitalization costs, obtain more affordable prices of the ingredient, reduce infection, and is easy tomodify the ingredients according to the patient's nutritional demands [10].

Commercial and blenderized enteral formulas are developed based on the specific patient's demands related to their health condition and named based on the diet: standard, high-energy, and high-protein formulas [11]. Several blenderized enteral formulas have been introduced, such as high-energy-protein enteral by combining with fish [12]. Local food ingredients can be combined to improve the nutrient content of the formula. However, it is necessary to consider the difficulty of obtaining these ingredients and the changing characteristics of the ingredients by cooking technique.

One of the local food ingredients that have the potential application as an enteral formula is referred to yellow pumpkin (*Cucurbita moschata*). It contains various nutrients such as protein, carbohydrates, fiber, phosphorus, and β-carotene of 2.29 g, 13.5 g, 3.64 g, 243 mg, and 2,118.15 mcg, respectively [12]. Pumpkin contains a source of carotenoids which contribute to a significant role in forming pro-vitamin A [13]. However, it is sensitive to the cooking process, such as heat or temperature. Foods with pumpkin-based ingredients can prevent eye disorders, skin diseases, and cancer [14]. According to FAO data, every year, the production of pumpkins in Indonesia continued to increase by 551,420 tons in 2020. Based on these data, pumpkin is one of the local foods that is applicable as an ingredient for enteral formula substitution [15]. In addition, this local food has a relatively low price. Thus, it has potentially developed as an alternative food.

Pumpkin has become one of the innovative enteral formula ingredients combined with duck eggs or snakehead fish and has shown high vitamin A content [16, 17]. Pumpkin fruit is a source of carotenoids and γ-aminobutyric acid [18, 19]. The administration of pumpkin porridge improves the body weight of malnourished babies [20]. The application of pumpkin substituted with fish in the enteral is expected to increase nutritional value, especially β-carotene. The study aimed to substitute the enteral formula with various blending times using a blender and analyze the β-carotene levels.

2 Method

2.1 Materials and Equipment

2.1.1 Materials

The materials employed for producing the enteral nutrition in this study were yellow pumpkin, tuna fish, sugar, skimmed milk, corn starch, coconut oil, chicken eggs, and water. The pumpkin was obtained from pumpkin farmers at the Nogosari traditional market, Boyolali, while the tuna was obtained from tuna suppliers at the Legi traditional market, Surakarta. The materials applied to analyze β-carotene levels included samples, aquadest, and $K_2Cr_2O_7$ solutions.

2.1.2 Equipment

The equipment employed for producing the enteral nutrition with variations of grinding times were a blender, stopwatch, food scale, steamer, pot, stirrer, and food thermometer. The equipment to analyze β-carotene levels included a spectrophotometer, micropipette, measuring pipette, volumetric flask, test tube, beaker glass, cuvette, vortex, and water bath.

2.2 Research Stages

2.2.1 Steamed Yellow Pumpkin

The pumpkin was peeled from the skin, cleaned of the jots and seeds, washed with water, cut into squares of 2–3 cm sizes, and steamed for 10 min over medium heat.

2.2.2 Production of Yellow Pumpkin as an Enteral Substitution

The production of yellow pumpkin *as an* enteral substitution is based on previous research [11] with modifications. The yellow pumpkin combined in the enteral was 120 g with various blending times (Table 1).

2.2.3 β-carotene Analysis of Yellow Pumpkin as an Enteral Substitution

Testing of β-carotene levels was conducted using the spectrophotometric method.

2.3 Research Design

This research was an experimental study using a single-factor completely randomized design (CRD) method with three variations of blending time. The treatment variation concerns the blending times of 30 s, 60 s, and 90 s. The experiment was repeated twice for each treatment. Each repetition was allocated three times for β-carotene levels analysis.

2.4 Statistical Analysis

Kolmogorov-Smirnov normality and homogeneity tests were employed to test the data, and the result was normal ($p \geq 0.05$). Furthermore, One-Way ANOVA parametric test was conducted at a significant level of 95% using the SPSS with series 25 program. There was an effect on nutrient analysis in each treatment, which can be continued with the Duncan Multiple Range Test (DMRT).

Table 1. Variations of Blending Time

Type of Blending Time	First Blending Time	Second Blending Time	Third Blending Time
T1 (30 s)	10 s	10 s	10 s
T2 (60 s)	20 s	20 s	20 s
T3 (90 s)	30 s	30 s	30 s

3 Result and Discussion

3.1 β-carotene Levels in Yellow Pumpkin and Enteral Standard

The applied pumpkin has a harvest period of 4 months and has yellow skin without green spots. It will affect β-carotene levels, regarding a sufficient harvest period of 3–4 months, and no green spots skin because it has a higher β-carotene content [22]. In addition, the steaming time is also considered for 10 min using medium heat so that the decrease in β-carotene levels is not excessive [23].

Based on Table 2, the β-carotene content of steamed pumpkin was lower than that of raw pumpkin. Steamed pumpkin β-carotene content was 2.75 mcg/g, and raw pumpkin content was 2.24 mcg/g. It was consistent with research showing that processing pumpkins can reduce β-carotene levels [23, 24].

3.2 β-carotene Levels in Yellow Pumpkin as an Enteral Substitution by Mixing Time Variation

Yellow pumpkin as an enteral substitution was processed using three variations of blending time. Table 3 shows that the longer the blending, the lower the β-carotene level. Statistical tests showed that the three treatments had different effects. The T1 treatment showed β-carotene levels of 4.75 mcg/100 g. It differed from the T2 treatment with β-carotene levels of 4.32 mcg/100 g. The two treatments presented different results on the T3 treatment with β-carotene levels of 4.11 mcg/100 g. This treatment presented significant results with $p = 0.00$ ($p < 0.05$). It means that the blending time influences the β-carotene levels.

β-carotene levels can be affected due to processing, such as blending. It was reported that grinding fresh carrots using commercial blenders for 20 s with the highest speed increased the release of β-carotene by 0.20–0.94 μg/g, which was significantly greater than chopped [25]. In contrast, microwaving treatment for 10 s after the bending to inactive the enzyme slightly decreased the β-carotene of the blended carrots [25]. Another study reported that there was an effect of grinding speed on β-carotene levels in the process of extracting antioxidants from moringa leaves [26]. The study showed that particle size could increase the release of nutrients or beneficial components such as β-carotene. Other factors that can reduce β-carotene content include the presence of oxygen, temperature, food composition, and structure. Processing activities, namely cutting, crushing, and mixing can damage fruit and vegetable tissues [23].

Table 2. β-carotene Levels on the yellow pumpkin and enteral standard

Ingredients	β-carotene Levels
Raw yellow pumpkin	2.75 mcg/g
Steamed yellow pumpkin	2.24 mcg/g
Enteral modisco	2.27 mcg/100 g
Enteral substitution with tuna	2.07 mcg/100 g

Table 3. β-carotene levels in yellow pumpkin as an enteral substitution with blending time variation

Blending time	β-carotene levels (mcg/100 g)			*p- value*
	1	2	3	
T1	4.75[c]			
T2		4.32[b]		0.00
T3			4.11[a]	

The different content of β-carotene with different mixing times in this study was possibly due to the heat generated during the mixing time with a blender. However, the heat generated was not measured. The longer the mixing time with a blender, the higher the heat generated. Thus, it decreased beta-carotene levels. Further research is required to test the researchers' assumptions.

Generally, β-carotene can be applied as a food coloring and fortification [27]. In addition, β-carotene also has antioxidant activity that can stabilize the oil from oxidation through the quenching mechanism in the photo-oxidation process. β-carotene definitely decomposes due to heat, light, oxygen, and acidic environmental conditions [28]. There are various amounts of β-carotene in foodstuffs. The processing of these foodstuffs affects the levels in each process. Home cooking methods such as steaming, boiling, and frying affect the nutrient content, especially β-carotene. The steaming process of pumpkin contains higher levels of β-carotene than other cooking processes [29]. Several factors influence them during the cooking and storage process, including heat, acid, light, and oxygen [30].

β-carotene, a type of carotenoid, has antioxidant properties that contribute against free radicals and can reduce disease risk. The roles of carotenoids in biological action include pro-vitamin A activity, immune response, antioxidant, drug/xenobiotic metabolism, and gap junction communication. In addition, carotenoids contribute to preventing cancer, HIV, cataracts, age-related macular degeneration (AMD), and cardiovascular disease (CVD) [30]. Therefore, this product is suitable for patients who require antioxidant intake to aid recovery. Combining pumpkin with enteral products is expected to provide unique benefits, such as the content of β-carotene, a type of antioxidant. In addition, pumpkin is believed to be beneficial as an anti-diabetic food because it has a hypoglycemic effect by increasing serum insulin levels, reducing blood glucose levels, and increasing glucose tolerance [31, 32].

4 Conclusion

Yellow pumpkin, as an enteral substitution, contains higher levels of β-carotene. The longer the blending time, the lower the impact of the β-carotene level.

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Authors' Contributions. SWA conducted laboratory analysis and drafted the manuscript; SR was involved in the conceptual design of the study, reviewed the draft, and finalized the manuscript. The authors read the final manuscript concurrently.

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