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ORIGINAL

Effectiveness Test of Pumpkin Seed (*Cucurbita moschata*) Capsules and Multiple Micronutrient Supplement (MMS) on Nutrient Intake and Hemoglobin Levels in Pregnant Women with Chronic Energy Deficiency (CED)

Prueba de eficacia de cápsulas de semilla de calabaza (*Cucurbita moschata*) y suplementos de micronutrientes múltiples (MMS) sobre la ingesta de nutrientes y los niveles de hemoglobina en mujeres embarazadas con deficiencia energética crónica (CED)

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ABSTRACT

Introduction: to compare the effects of pumpkin seed capsules and Multiple Micronutrient Supplements (MMS) on nutrient intake, Mid-Upper Arm Circumference (MUAC), and hemoglobin levels in pregnant women with CED and anemia.
Method: a quasi-experimental non-randomized pre-posttest control group design was conducted among 61 pregnant women. The intervention group received pumpkin seed capsules (2 × 700 mg/day), while the control group received MMS (30 mg iron + 15 micronutrients) for 60 days.
Results: both groups showed significant increases in nutrient intake, MUAC, and hemoglobin levels ($p < 0,05$). Mean MUAC increased by 1,83 cm in the intervention group and 1,55 cm in the control group. Hemoglobin levels rose by 1,48 g/dL and 1,47 g/dL, respectively, with no significant difference between groups ($p > 0,05$).
Conclusion: pumpkin seed capsules are as effective as MMS in improving nutritional status and hemoglobin levels among pregnant women with CED, suggesting their potential as a local food-based supplement.

Keywords: Pumpkin Seed (*Cucurbita moschata*); CED; Anemia; Pregnant Women; MMS.

RESUMEN

Introducción: comparar los efectos de las cápsulas de semilla de calabaza y los Suplementos de Micronutrientes Múltiples (MMS) sobre la ingesta de nutrientes, la circunferencia braquial (CMB) y los niveles de hemoglobina en mujeres embarazadas con ECE y anemia.
Método: se realizó un diseño cuasiexperimental, no aleatorizado, con grupo control pre-postest en 61 mujeres embarazadas. El grupo de intervención recibió cápsulas de semilla de calabaza (2 × 700 mg/día), mientras que el grupo control recibió MMS (30 mg de hierro + 15 micronutrientes) durante 60 días.
Resultados: ambos grupos mostraron aumentos significativos en la ingesta de nutrientes, la CMB y los niveles de hemoglobina ($p < 0,05$). La CMB media aumentó 1,83 cm en el grupo de intervención y 1,55 cm en el grupo control. Los niveles de hemoglobina aumentaron 1,48 g/dL y 1,47 g/dL, respectivamente, sin diferencias significativas entre los grupos ($p > 0,05$).
Conclusión: las cápsulas de semillas de calabaza son tan eficaces como el MMS para mejorar el estado nutricional y los niveles de hemoglobina en mujeres embarazadas con ECE, lo que sugiere su potencial como

suplemento alimenticio local.

Palabras clave: Semilla de Calabaza (*Cucurbita moschata*); CED; Anemia; Mujeres Embarazadas; MMS.

INTRODUCTION

Pregnancy is a critical period that determines the quality of human resources, as maternal nutritional status directly affects fetal growth and development. Globally, nutritional problems such as Chronic Energy Deficiency (CED) and anemia remain highly prevalent.[1] The World Health Organization (WHO) reports that 35-75 % of pregnant women worldwide experience CED and anemia, contributing to nearly 40 % of maternal deaths in developing countries.[2] In Indonesia, the 2018 Basic Health Research (Riskesdas) recorded a CED prevalence of 23,3-33,5 %, while the 2023 Indonesian Nutrition Status Survey (SSGI) found that almost three in ten pregnant women were anemic and 17 % were at risk of CED.[3] These conditions increase the likelihood of low birth weight (LBW), pregnancy complications, and fetal death.

At the individual level, CED is commonly identified through Mid-Upper Arm Circumference (MUAC) measurements below 23,5 cm, which indicate inadequate energy reserves and are associated with anemia and impaired fetal growth.[4] Previous studies have shown strong relationships between CED, low energy-protein intake, and anemia.[5,6] To mitigate these problems, the government provides iron and folic acid supplementation (Tablet Tambah Darah/TTD). However, adherence to the recommended 90 tablets during pregnancy remains low both nationally and in South Sulawesi.[3,7] largely due to side effects and limited awareness among pregnant women.[8,9] Multiple Micronutrient Supplements (MMS), which contain 15 essential vitamins and minerals, have been shown to be more effective than TTD in reducing LBW risk and improving hemoglobin levels.[10,11] Despite this advantage, MMS uptake is still limited, as compliance is influenced by sociodemographic factors, family support, and perceived side effects.[12] These limitations highlight the need for alternative or complementary strategies that are acceptable, accessible, and based on local food sources.

Pumpkin seeds (*Cucurbita moschata*) have emerged as a promising food-based option due to their rich content of energy, protein, iron, zinc, folate, vitamins A and C, and antioxidants. Their protein and amino acid components play important roles in iron transport, while zinc and omega-3 fatty acids support appetite and metabolic processes [13,14,15,16] Previous evidence indicates that biscuits fortified with pumpkin seeds can improve energy, protein, fat, and mineral (Fe, Zn) intake among adolescents. Additionally, pumpkin seed capsule supplementation for 60 days has been shown to increase hemoglobin levels in pregnant women [17] and similar effects have been observed among women of reproductive age consuming pumpkin seed extract.[18] Although these findings suggest the potential of pumpkin seeds to improve maternal nutritional status, evidence remains limited, particularly regarding their impact on pregnant women experiencing CED. A clear gap persists in understanding whether pumpkin seed supplementation can effectively improve nutrient intake, hemoglobin levels, and anthropometric status in this high-risk group. Therefore, this study aimed to evaluate the effects of pumpkin seed capsule supplementation on nutrient intake, hemoglobin levels, and MUAC among pregnant women with Chronic Energy Deficiency (CED).

METHOD

Research Design

This study employed a quasi-experimental, non-randomized controlled trial with a pre-posttest design. The study was conducted in two community health center (Puskesmas) areas in Takalar Regency: Aeng Towa and Bontomarannu. The Aeng Towa area served as the intervention site, while Bontomarannu functioned as the control site. Non-random allocation by individual was not feasible due to operational constraints related to the local health program's existing supplementation distribution system. This cluster-based assignment was used for pragmatic reasons but is acknowledged as a methodological limitation that may introduce selection or performance bias.[19]

Sampling Design

Screening was conducted for all pregnant women attending the two Puskesmas to assess gestational age, MUAC, and hemoglobin levels. Women were eligible if they were 13-28 weeks pregnant, had MUAC < 23,5 cm, hemoglobin < 11 g/dL, and agreed to participate for 60 days. Those with chronic illnesses were excluded. Participants who met all criteria were selected using simple random sampling within each site. Reasons for withdrawal included allergic reactions, miscarriage, severe side effects, low compliance (<80 %), relocation, or incomplete follow-up. A CONSORT-style flow diagram will be included to describe the progression from screening to analysis. The sample size was calculated based on the primary outcome, hemoglobin change.

Using α = 0,05; 80 % power, an expected difference of 1,0 g/dL, and a standard deviation of 1,2 g/dL, at least 25 women per group were required. With an anticipated 15 % dropout rate, the final target was 29 participants per group.

Intervention and Control

The intervention group received pumpkin seed flour capsules at a dose of 2 × 700 mg/day for 60 days. Pumpkin seeds were cleaned, dried, milled, and encapsulated, and their nutrient composition was analyzed by an accredited laboratory. Capsules were stored in airtight containers to maintain stability. The control group received Multiple Micronutrient Supplements (MMS) distributed by the health service, containing 30 mg iron and 15 additional micronutrients consistent with WHO–UNICEF guidelines.[20] No placebo was used, which represents a methodological limitation.

Outcome Measures and Instruments

The primary outcomes were changes in hemoglobin concentration and MUAC after 60 days. Secondary outcomes included changes in nutrient intake and the prevalence of anemia and CED. MUAC was measured in triplicate using a non-stretch tape, and hemoglobin levels were assessed through capillary blood using a validated portable photometer (HemoCue Hb 301). Dietary intake was collected through two non-consecutive 24-hour recalls conducted by trained nutritionists, and nutrient analysis used NutriSurvey software with the Indonesian Food Composition Table.

Data Collection and Analysis

Data were recorded using standardized forms and checked routinely for completeness. Double data entry was conducted to minimize errors. Statistical analysis was performed using SPSS, with Shapiro–Wilk testing for normality. Depending on data distribution, paired t-tests or Wilcoxon tests were used for within-group comparisons, and independent t-tests or Mann–Whitney U tests for between-group differences. Categorical variables were analyzed using chi-square tests, with significance set at $p < 0,05$.

RESULTS

Based on table 1, most pregnant women with CED were in the non-risk age group (20–35 years), accounting for 67,7 % of the intervention group and 83,3 % of the control group, and the majority were unemployed (93,5 % and 86,7 %, respectively). Most participants were multigravida (83,9 % vs. 80,0 %) and in their second trimester (93,5 % vs. 90,0 %).

Table 1. The characteristics of the respondents

Variable	Groups				Total	%	P Value*
	Intervention		Control				
	(31)	%	(30)	%			
Age (Year)							0,157
<20 or >35	10	32,3	5	16,7	15	32,6	
20–35	21	67,7	25	83,3	46	65,4	
Employment Status							0,367
Employed	2	6,5	4	13,3	6	10,9	
Unemployed	29	93,5	26	86,7	55	89,1	
Parity							0,694
Primigravida	5	16,1	6	20,0	11	22	
Multigravida	26	83,9	24	80,0	50	78	
Gestational Age							0,614
Trimester 1	2	6,5	3	10,0	5	8,9	
Trimester 2	29	93,5	27	90,0	56	91,1	

Note: **Chi Square*

Statistical analysis demonstrated no significant differences between the intervention and control groups regarding age, employment status, parity, or gestational age, suggesting that both groups were comparable and homogeneous.

Table 2 shows improvements in maternal nutritional status, anemia, and body weight after the intervention. The prevalence of CED decreased from 100 % at baseline to 51,6 % in the intervention group and 66,7 % in the control group, while anemia declined from 100 % to 38,7 % and 63,3 %, respectively, with greater reductions in underweight status observed in the pumpkin seed capsule group than in the MMS group.

Table 2. Distribution of Changes in CED, Anemia, and Body Weight Status in the Intervention and Control Groups

Variable	Intervention				Control				Total	%
	Pre		Post		Pre		Post			
	n=31	%	n=31	%	n=30	%	n=30	%		
CED Status										
CED (<23,5 cm)	31	100	16	51,6	30	100	20	66,7	36	59
Normal (≥23,5 cm)	0	0	15	48,4	0	0	10	33,3	25	41
Anemia Status										
Anemia (Hb <11 g/dL)	31	100	12	38,7	30	100	19	63,3	31	51
Normal (Hb ≥11 g/dL)	0	0	19	61,3	0	0	11	36,7	30	49
Body Weight Status										
Normal or	16	51,6	25	80,6	21	70,0	28	93,3	53	86
Underweight	15	48,4	6	19,4	9	30,0	2	6,7	8	14

Table 3. Analysis of Nutrient Intake Differences Before and After Intervention Among Pregnant Women with Chronic Energy Deficiency (CED) and Anemia

Nutrient	Before (Mean ± SD)	AKG (%)	After (Mean ± SD)	AKG (%)	P-Value[a]	Difference (Mean ± SD)
Energy (kcal)						
Intervention	1168,7 ± 100,9	54	1219,4 ± 117,5	56	0,000*	50,7 ± 16,6
Control	1276,6 ± 52,8	59	1391,9 ± 61,6	64	0,000*	115,3 ± 8,8
P Value[b]	0,002		0,000			0,000
Protein (g)						
Intervention	53,1 ± 4,4	75	55,0 ± 5,3	78	0,000*	1,9 ± 0,9
Control	28,6 ± 1,7	41	31,2 ± 1,9	44	0,000*	2,6 ± 0,2
P Value[b]	0,003		0,000			0,001
Carbohydrates (g)						
Intervention	131,5 ± 10,4	32	135,7 ± 11,4	33	0,000*	4,2 ± 1,0
Control	165,8 ± 6,5	41	180,5 ± 7,5	45	0,000*	14,7 ± 1,0
P Value[b]	0,006		0,000			0,000
Fat (g)						
Intervention	47,0 ± 4,0	70	48,5 ± 4,8	71	0,000*	1,5 ± 0,8
Control	37,2 ± 2,4	55	40,2 ± 2,8	59	0,000*	3,0 ± 0,4
P Value[b]	0,000		0,000			0,000
Zinc (mg)						
Intervention	6,24 ± 0,73	42	6,57 ± 0,85	42	0,000*	0,33 ± 0,12
Control	2,96 ± 0,18	21	3,13 ± 0,20	21	0,000*	0,17 ± 0,02
P Value[b]	0,008		0,002			0,001
Iron (mg)						
Intervention	7,25 ± 0,76	20	7,77 ± 0,94	22	0,000*	0,52 ± 0,18
Control	7,46 ± 0,63	21	8,19 ± 0,73	23	0,000*	0,73 ± 0,10
P Value[b]	0,280		0,120			0,001
Folate (mcg)						
Intervention	119,3 ± 8,2	20	124,0 ± 11,4	21	0,000*	4,7 ± 3,2
Control	171,2 ± 10,9	28	188,7 ± 12,1	31	0,000*	17,5 ± 1,2
P Value[b]	0,002		0,000			0,000
Vitamin A (mcg)						
Intervention	726,1 ± 25,9	81	749,1 ± 46,9	83	0,000*	23,0 ± 21,0
Control	263,9 ± 15,3	29	285,4 ± 17,9	31	0,000*	21,5 ± 2,6
P Value[b]	0,000		0,000			0,180
Vitamin C (mcg)						
Intervention	19,3 ± 1,9	20	20,4 ± 2,5	21	0,000*	1,1 ± 0,6
Control	20,3 ± 3,0	21	22,1 ± 3,4	23	0,000*	1,8 ± 0,4
P Value[b]	0,018		0,160			0,041

Note: [a]Wilxocon; [b]Mann-Whitney

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Table 3 shows that both groups experienced significant increases in energy, protein, carbohydrates, fat, zinc, iron, folate, vitamin A, and vitamin C after the intervention (p=0,000 in the intervention group and p<0,05 in the control group), with no significant baseline differences between them. Although nutrient intake improved in both groups and the pumpkin seed capsule group showed positive effects, post-intervention differences between groups were not significant for key nutrients such as energy, protein, and carbohydrates.

Table 4. Analysis of Differences in Mid-Upper Arm Circumference (MUAC) Before and After Intervention Among Pregnant Women with Chronic Energy Deficiency (CED) and Anemia

Groups	Before		After		P Value[a]	Differences	
	Mean (SD)	Median (Min-Max)	Mean (SD)	Median (Min-Max)		Mean (SD)	Median (Min-Max)
Intervention (n=31)	21,32 (1,31)	21,9 (18,5-23,0)	23,15 (1,48)	23,3 (19,0-26,0)	0,000	1,83 (1,14)	2,0 (0,0-4,4)
Groups (n=30)	21,13 (1,48)	21,2 (18,0-23,0)	22,69 (1,50)	22,5 (19,8-25,7)	0,000	1,55 (0,82)	1,65 (0,3-3,6)
P Value[b]	0,140		0,080			0,312	

Note: [a]Wilxocon; [b]Mann-Whitney

Analysis of MUAC showed no significant differences between groups at baseline or post-intervention (p=0,140 and p=0,080), although both groups demonstrated significant within-group improvements (p=0,000), with mean increases of 1,83 cm in the intervention group and 1,55 cm in the control group. Despite the Mann-Whitney test showing no significant between-group difference (p=0,312), the intervention group exhibited a slightly greater improvement.

Table 5. Analysis of Differences in Hemoglobin (Hb) Levels Before and After Intervention Among Pregnant Women with Chronic Energy Deficiency (CED) and Anemia

Groups	Before		After		P Value[a]	Differences	
	Mean (SD)	Median (Min-Max)	Mean (SD)	Median (Min-Max)		Mean (SD)	Median (Min-Max)
Intervention (n=31)	9,10 (1,23)	9,2 (6,4-10,8)	10,58 (1,73)	11,0 (7,0-13,3)	0,000	1,48 (1,03)	1,5 (0,0-3,4)
Control (n=30)	8,89 (0,83)	8,9 (7,0-10,0)	10,36 (1,47)	10,4 (7,0-13,0)	0,000	1,47 (0,98)	1,4 (0,2-3,7)
P Value[b]	0,459		0,459			0,982	

Note: [a]Wilxocon; [b]Mann-Whitney

Analysis of hemoglobin levels revealed no significant differences between the two groups before or after the intervention (p=0,459). Both the intervention and control groups showed significant increases in hemoglobin following the intervention (p=0,000), with mean increments of 1,48 g/dL and 1,47 g/dL, respectively. The Mann-Whitney test showed no significant difference between groups (p=0,982), although the improvement was slightly higher in the intervention group.

DISCUSSION

This study demonstrated that pumpkin seed capsules provided meaningful improvements in energy and micronutrient intake, MUAC, and hemoglobin levels among pregnant women with CED after 60 days of intervention. Although the control group receiving MMS showed slightly larger increases in several nutrient intakes, the differences between groups were not statistically significant. Both groups experienced significant improvements in MUAC and Hb, with nearly identical changes in hemoglobin concentration. The significant increases in macro- and micronutrient intake in the pumpkin seed group, despite the absence of fortified complementary foods (PMT), indicate that pumpkin seed capsules alone contributed substantially to meeting nutritional needs among pregnant women with CED. The enhanced intake aligns with findings from [16], where pumpkin seed-based biscuits consumed over 90 days improved energy, protein, and mineral intake.

In contrast, the MMS group demonstrated numerically greater increases in micronutrient intake. This difference may reflect the inherently higher micronutrient density and bioavailability of MMS formulations, which are designed to deliver precise amounts of essential nutrients. Additionally, the control area received external support such as formula milk and PMT, which likely amplified nutrient intake. This pattern is consistent with [20], ho reported that supplementary fortified foods significantly boosted nutrient intake beyond what could be achieved through standard dietary patterns.

Interestingly, the pumpkin seed group still achieved statistically significant gains without external supplements—suggesting high acceptability and good adherence, which are often barriers to TTD or MMS consumption. Unlike synthetic supplements, food-based products tend to produce fewer side effects, potentially improving daily compliance. Despite the absence of external nutritional support, the intervention group still achieved significant improvements solely from regular dietary intake and the pumpkin seed capsules. This aligns with the study that pumpkin seed biscuits consumed for 90 days improved maternal nutritional status, reflected by increased body weight, mid-upper arm circumference (MUAC), and serum zinc levels. These improvements suggest enhanced macro- and micronutrient intake, particularly energy, protein, and zinc, contributing to better maternal nutritional outcomes.

Consistent with Gupta et al.[21], pumpkin seeds contain essential micronutrients that support maternal nutrition, although their natural form requires longer and larger consumption compared to synthetic supplements. Therefore, pumpkin seed capsules remain a promising locally based nutritional intervention, even if their short-term effect is slightly weaker than MMS in increasing total nutrient intake. Increases in MUAC observed in both groups indicate improved energy balance and tissue accretion. The slightly greater increase in the pumpkin seed group, although not statistically significant, is noteworthy considering the absence of additional food support. Studies by [16], and Nurrahmi[17] similarly reported increases in MUAC following pumpkin seed supplementation, suggesting that pumpkin seeds can meaningfully support improvements in maternal anthropometric status when consumed consistently. Possible reasons for similar MUAC increases between groups include:

- The relatively short intervention duration (60 days), which may not be long enough for major differences in body composition to emerge.
- Potential confounding dietary intake in the control group from fortified foods.
- Shared biological pathways of both interventions in supporting energy metabolism and protein synthesis.

Both pumpkin seed capsules and MMS resulted in substantial improvements in Hb levels (Δ ≈ 1,48 g/dL for the pumpkin seed group and Δ ≈ 1,47 g/dL for MMS). The comparable magnitude of improvement suggests that pumpkin seeds, despite providing non-heme iron with lower bioavailability, still deliver sufficient micronutrients and supporting factors to enhance hematopoiesis. Studies by Musaidah et al.[22] and Mashayekh-Amiri et al.[23] found similar improvements in Hb and ferritin following pumpkin seed-based supplementation.

The similarity in Hb increase between groups can be explained by several factors:

- Short intervention period (60 days): Iron supplementation typically reaches peak efficiency after ≥12 weeks, so differences between plant-based and synthetic sources may not fully manifest.
- Presence of absorption-enhancing nutrients: Pumpkin seeds contain vitamin A, zinc, and antioxidants, which synergistically improve iron absorption and erythropoiesis.
- Absence of severe side effects: Pumpkin seed capsules may promote better adherence over time compared to iron tablets, which often cause nausea and constipation.

Nevertheless, synthetic MMS formulas contain highly bioavailable iron and multiple hematopoietic cofactors. That both interventions produced equivalent Hb improvements suggests that the overall nutritional environment—including increased dietary intake—played an important role in mediating hematologic recovery. Compared to studies showing greater Hb increases with MMS, the absence of a between-group difference here may be attributable to:

- Lower baseline Hb variability within the sample.
- High adherence to pumpkin seed capsules, minimizing the typical gap in compliance observed in iron supplementation programs.
- Similar maternal dietary patterns across both study sites.
- Differences in co-interventions, such as fortified foods in the MMS group.

Compared to trials where pumpkin seed products produced larger anthropometric improvements, the shorter duration in this study (60 vs. 90 days) likely reduced the relative effect size. Pumpkin seed nutrients—particularly non-heme iron and zinc—require sustained intake for optimal physiological impact due to lower absorption efficiency compared to synthetic supplements. Pumpkin seeds contain high-quality plant protein, essential amino acids, unsaturated fatty acids, and key micronutrients including zinc, iron, magnesium, and folate.[24] Zinc enhances appetite and stimulates enzymatic activity central to protein metabolism [25], which may explain increases in dietary intake and MUAC. Protein and essential fatty acids support muscle accretion, preventing catabolism and contributing to upper-arm tissue gains.[26] Zinc also plays a key role in appetite regulation and energy metabolism; its deficiency has been linked to weight loss and poor appetite.(25,27) Iron, folate, vitamin A, and antioxidant compounds in pumpkin seeds collectively support erythropoiesis. However, non-heme iron is absorbed at only 3-5 %, far below the 25–30 % absorption of heme iron from animal foods. Competition between zinc and iron for the DMT-1 intestinal transporter may further reduce absorption efficiency. These mechanisms clarify why pumpkin seed capsules improved Hb but did not surpass MMS. Nevertheless, the presence of multiple micronutrients and antioxidants creates a synergistic environment that enhances maternal metabolic function and hematologic performance.(28,29)

Limitations

Several limitations must be acknowledged. The non-randomized design limits causal inference and raises the possibility of residual confounding. The absence of a placebo prevented blinding and may have introduced measurement or behavioral bias. Differences in external dietary support, such as formula milk and PMT in the control site, may have affected nutrient intake and anthropometric outcomes. The short 60-day duration may not have captured the full hematologic effect of either intervention, especially for plant-based iron with lower bioavailability. Finally, the study did not include biochemical markers such as ferritin or zinc levels, limiting the ability to assess nutrient absorption.

CONCLUSIONS

This study demonstrates the potential of pumpkin seed capsules as a locally available, food-based nutritional intervention to support improvements in the nutritional well-being of pregnant women with Chronic Energy Deficiency (CED). Although they did not surpass the effectiveness of MMS, the capsules contributed meaningfully to enhancing maternal nutritional status within a relatively short intervention period. The findings highlight the promise of pumpkin seeds as a complementary or alternative option to conventional synthetic supplements—particularly in settings where acceptability, tolerance, and adherence to standard iron or MMS supplementation are challenges. As a culturally acceptable and affordable local resource, pumpkin seeds offer an opportunity to strengthen community-based maternal nutrition programs in a sustainable manner. Further research using randomized controlled designs, longer intervention durations, and more comprehensive biochemical assessments is warranted to validate long-term benefits and clarify the biological mechanisms underlying the effects of pumpkin seed supplementation.

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