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# Effect of Vitamin A and C Supplementation on Glucose Tolerance in Healthy Female Volunteers: A Repeated-Measures Oral Glucose Tolerance Study

Kadiri Muhammed Lawal[1*]; A. A. Jigam[1]

[1]Department of Biochemistry, Faculty of Life Sciences, Federal University of Technology, Minna, Niger State, Nigeria

Correspondence Author: Kadiri Muhammed Lawal[1*]

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**Abstract:**

- ***Background:***

**Glucose tolerance is a key indicator of metabolic health, and micronutrients such as vitamins A and C are known to influence glucose metabolism. However, the synergistic effects of these two vitamins on postprandial glucose dynamics remain poorly characterised, particularly in African populations.**

- ***Objective:***

**This study investigated the individual and combined effects of oral vitamin A (100,000 IU) and vitamin C (1,000 mg) supplementation on glucose tolerance in apparently healthy female volunteers.**

- ***Methods:***

**Twenty (20) apparently healthy, non-diabetic, non-smoking female subjects were recruited from the Federal University of Technology, Minna community. A repeated-measures design was used across four phases: glucose alone (Phase 1/control), glucose + vitamin A (Phase 2), glucose + vitamin C (Phase 3), and glucose + vitamins A and C (Phase 4). Each subject received 75 g of oral glucose dissolved in 200 mL of water, and fingertip capillary blood glucose was measured at 0 (fasting), 30, 60, 90, 120, and 150 minutes using a calibrated glucometer. Data were analysed using one-way ANOVA with Tukey-Kramer post hoc test and expressed as Mean ± SEM (n = 20). Significance was set at $p \leq 0.05$.**

- ***Results:***

**Fasting blood glucose levels did not differ significantly across all four phases ($p > 0.05$). In all phases, blood glucose rose significantly from baseline at 30 minutes, peaking between 30–60 minutes, then declining progressively toward 150 minutes. Phase 2 (glucose + vitamin A) produced the highest glucose surge at 30 minutes (104.80 ± 3.44 mg/dL) compared to the control (93.30 ± 4.43 mg/dL). Phases 3 and 4 showed glucose curves closely paralleling the control. Phase 4 subjects showed a secondary rise at 120 minutes (102.00 ± 2.38 mg/dL), though glucose declined significantly by 150 minutes.**

- ***Conclusion:***

**Vitamin A supplementation transiently amplifies early postprandial glucose elevation, possibly through enhanced pancreatic beta-cell insulin signalling. Vitamin C supplementation did not significantly alter glucose tolerance profiles. The combined supplementation of vitamins A and C demonstrated a delayed secondary glucose rise, suggesting a potential modulatory effect on glucose absorption and disposal. These findings support the potential role of vitamin supplementation as an adjunct strategy in glycaemic management.**

***Keywords:*** *Glucose Tolerance; Oral Glucose Tolerance Test (OGTT); Vitamin A; Vitamin C; Postprandial Glycaemia; Diabetes Mellitus; Micronutrient Supplementation.*

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## I. INTRODUCTION

Blood glucose homeostasis is a tightly regulated physiological process essential for energy supply to all cells and tissues. Normal fasting blood glucose is maintained within the range of 3.5–5.5 mmol/L, and postprandial deviations are rapidly corrected through hormonal and metabolic mechanisms (Güemes et al., 2015). Any sustained disruption of this balance underpins the pathogenesis of diabetes mellitus (DM), a metabolic disorder characterised by chronic hyperglycaemia and dysregulation of carbohydrate, protein, and lipid metabolism (Berlanga-Acosta et al., 2013).

The global burden of diabetes continues to rise, with type 2 diabetes mellitus (T2DM) accounting for approximately 90% of all cases. Mounting evidence indicates that micronutrient deficiencies — particularly of vitamins — are closely linked to impaired glucose metabolism and the risk of developing T2DM (Carneiro et al., 2013). Among these, vitamins A and C have attracted particular scientific interest. Vitamin A, a fat-soluble micronutrient, plays critical roles in pancreatic beta-cell function, insulin sensitivity, and retinoid receptor-mediated gene regulation (Karolina et al., 2018). Vitamin C, a water-soluble antioxidant, competes with glucose for cellular uptake via insulin-mediated transport and has been reported to reduce oxidative stress, glycosylation, and sorbitol accumulation in diabetic patients (Opara, 2004; Shukla et al., 2012).

Despite independent lines of evidence supporting the roles of vitamins A and C in glucose metabolism, their combined effect on postprandial glucose dynamics has received limited investigation. Since both vitamins are commonly co-ingested through diet or multivitamin supplements, understanding their synergistic effects is clinically relevant. Furthermore, there is a paucity of studies examining this interaction within Nigerian and sub-Saharan African populations, where both micronutrient deficiencies and diabetes prevalence are rising concerns.

The oral glucose tolerance test (OGTT) remains the gold standard for evaluating glucose disposal capacity and diagnosing impaired glucose tolerance (IGT) and T2DM (Brazis, 2004). Its clinical utility extends to characterising the metabolic effects of dietary and pharmacological interventions on insulin secretion and insulin resistance (Inzucchi, 2012).

This study therefore aimed to investigate the individual and combined effects of oral vitamin A and vitamin C supplementation on glucose tolerance in apparently healthy female volunteers, using a standardised OGTT protocol. The findings are intended to contribute to the growing evidence base on micronutrient–glucose interactions and their potential implications for diabetes prevention and management.

## II. MATERIALS AND METHODS

➢ *Study Design and Setting*

This was a repeated-measures, within-subject experimental study conducted in the Department of Biochemistry, Faculty of Life Sciences, Federal University of Technology, Minna, Niger State, Nigeria. The same cohort of subjects participated across four experimental phases conducted on four separate days, allowing each participant to serve as their own control.

➢ *Study Participants*

Twenty (20) apparently healthy female subjects were randomly recruited from the university community. Inclusion criteria required that participants be non-diabetic, non-smoking, and clinically normal at the time of recruitment. Subjects with known metabolic disorders, concurrent illnesses, or current use of medications known to affect glucose metabolism were excluded. Informed verbal consent was obtained from all participants prior to enrolment. No financial or material incentives were offered.

➢ *Materials and Reagents*

Blood glucose measurements were performed using a calibrated glucometer (AccuChek™) with compatible test strips. Supporting materials included lancets, cotton wool, methylated spirit, glass cups, beakers, a stop clock, and a weighing balance. D-Glucose (Fisher Scientific Company, Chemical Manufacturing Division, Fair Lawn, NJ, USA) was used as the oral glucose challenge. Vitamin A tablets (100,000 IU) and Vitamin C tablets (1,000 mg) were sourced commercially.

➢ *Experimental Protocol*

Each subject participated in four phases, conducted on four separate days with sufficient washout intervals between phases to minimise carryover effects. All procedures were performed in the morning following a 12-hour overnight fast. Capillary fingertip blood samples were collected at 0 (fasting baseline), 30, 60, 90, 120, and 150 minutes following test substance administration. Each blood sample was placed on a test strip inserted into the glucometer, which provided a direct digital reading within seconds.

- Phase 1 — Glucose Only (Control): Subjects received 75 g of glucose dissolved in 200 mL of water orally. This served as the reference control for all subsequent comparisons.
- Phase 2 — Glucose + Vitamin A: Subjects received the same standard glucose solution (75 g/200 mL) simultaneously with 100,000 IU of vitamin A tablet administered orally.
- Phase 3 — Glucose + Vitamin C: Subjects received 75 g/200 mL glucose simultaneously with 1,000 mg of vitamin C tablet administered orally.
- Phase 4 — Glucose + Vitamin A + Vitamin C: Subjects received 75 g/200 mL glucose simultaneously with both

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100,000 IU vitamin A and 1,000 mg vitamin C tablets administered orally.

➢ *Statistical Analysis*

Data are expressed as Mean ± Standard Error of Mean (SEM) for n = 20 subjects per phase. Differences in blood glucose levels within and between phases were assessed using one-way analysis of variance (ANOVA) with Tukey-Kramer multiple comparison post hoc test. Statistical significance was set at $p \leq 0.05$. Time-course glucose curves were plotted for each phase to illustrate the postprandial glycaemic pattern.

➢ *Ethical Considerations*

Verbal informed consent was obtained from all participants prior to their inclusion in the study. Participation was entirely voluntary. All procedures were non-invasive in nature, and the study adhered to ethical principles consistent with the Declaration of Helsinki.

## III. RESULTS

➢ *Fasting Blood Glucose*

The mean fasting blood glucose (FBG) levels across all four experimental phases were comparable and showed no statistically significant differences ($p > 0.05$). Mean FBG values were 64.15 ± 2.07 mg/dL (Phase 1), 65.40 ± 1.55 mg/dL (Phase 2), 60.60 ± 1.85 mg/dL (Phase 3), and 67.00 ± 2.24 mg/dL (Phase 4), all within the normal fasting range. This confirms physiological equivalence at baseline across all study days.

➢ *Postprandial Blood Glucose Response*

Table 1 presents the mean blood glucose concentrations at each time point for all four phases. In all phases, blood glucose levels rose significantly from fasting baseline following oral glucose administration ($p \leq 0.05$).

Table 1 Mean Blood Glucose Concentrations (mg/dL) Across Four Experimental Phases (Mean ± SEM, n = 20)

| Time (min) | Glucose Only (mg/dL) | Glucose + Vit. A (mg/dL) | Glucose + Vit. C (mg/dL) | Glucose + Vit. A & C (mg/dL) |
|---|---|---|---|---|
| FBS (0) | 64.15 ± 2.07 | 65.40 ± 1.55 | 60.60 ± 1.85 | 67.00 ± 2.24 |
| 30 | 93.30 ± 4.43b,c | 104.80 ± 3.44c,d | 94.30 ± 2.85b | 95.10 ± 3.66b |
| 60 | 101.15 ± 2.85c | 105.80 ± 3.19d | 97.40 ± 4.25b | 99.45 ± 3.27b |
| 90 | 96.35 ± 3.29b,c | 94.50 ± 2.64b,c | 98.25 ± 2.87b | 96.80 ± 3.38b |
| 120 | 94.35 ± 1.81b,c | 98.45 ± 1.96c,d | 88.95 ± 2.25b | 102.00 ± 2.38b |
| 150 | 86.10 ± 2.57b | 84.05 ± 2.48b | 89.50 ± 2.83b | 93.60 ± 3.36b |

*Values sharing the same superscript letter within a column are not significantly different ($p > 0.05$). FBS = Fasting Blood Sugar. Results expressed as Mean ± SEM.*

➢ *Phase 1 — Glucose Only (Control)*

In the control phase, blood glucose rose from a fasting level of 64.15 ± 2.07 mg/dL to 93.30 ± 4.43 mg/dL at 30 minutes, reaching a peak of 101.15 ± 2.85 mg/dL at 60 minutes. A gradual decline was observed thereafter, with levels of 96.35 ± 3.29 mg/dL at 90 minutes, 94.35 ± 1.81 mg/dL at 120 minutes, and 86.10 ± 2.57 mg/dL at 150 minutes. This pattern is consistent with the normal postprandial glycaemic response described in the literature.

➢ *Phase 2 — Glucose + Vitamin A*

Co-administration of vitamin A with glucose produced the highest initial blood glucose surge of all phases, reaching 104.80 ± 3.44 mg/dL at 30 minutes — significantly higher than the control at the same time point. A peak of 105.80 ± 3.19 mg/dL was recorded at 60 minutes, followed by a decline to 94.50 ± 2.64 mg/dL at 90 minutes. A secondary, modest increase was noted at 120 minutes (98.45 ± 1.96 mg/dL), before a pronounced fall to 84.05 ± 2.48 mg/dL at 150 minutes, the lowest recorded value in this phase.

➢ *Phase 3 — Glucose + Vitamin C*

The glucose curve for Phase 3 most closely paralleled the control (Phase 1). Blood glucose rose to 94.30 ± 2.85 mg/dL at 30 minutes and continued to a peak of 97.40 ± 4.25 mg/dL at 60 minutes. Unlike other phases, a slight — though non-significant — secondary peak was observed at 90 minutes (98.25 ± 2.87 mg/dL), suggesting a marginally delayed peak in this phase. A decline followed, reaching 88.95 ± 2.25 mg/dL at 120 minutes and a slight increase to 89.50 ± 2.83 mg/dL at 150 minutes. No statistically significant differences were observed between Phase 3 and Phase 1 at any time point ($p > 0.05$).

➢ *Phase 4 — Glucose + Vitamins A and C*

Phase 4 produced a glucose curve broadly similar to the control, with an initial rise to 95.10 ± 3.66 mg/dL at 30 minutes and a peak of 99.45 ± 3.27 mg/dL at 60 minutes. A decrease to 96.80 ± 3.38 mg/dL was noted at 90 minutes, followed by the most prominent secondary rise of any phase at 120 minutes (102.00 ± 2.38 mg/dL). Blood glucose then declined markedly to 93.60 ± 3.36 mg/dL at 150 minutes, which remained higher than the 150-minute values of phases 1, 2, and 3, suggesting a more prolonged glucose clearance in the combined supplementation group.

## IV. DISCUSSION

This study investigated the effects of oral supplementation with vitamin A, vitamin C, and their combination on postprandial blood glucose dynamics in healthy female volunteers using a standardised oral glucose tolerance test (OGTT). The principal findings were: (i) fasting blood glucose was comparable across all phases; (ii) vitamin A co-administration significantly amplified the early postprandial glucose surge; (iii) vitamin C supplementation

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did not significantly alter the glucose tolerance curve; and (iv) combined vitamin A and C supplementation produced a delayed secondary rise in blood glucose at 120 minutes, with the slowest return toward baseline.

The significantly elevated postprandial glucose observed in Phase 2 (glucose + vitamin A) is consistent with the known role of vitamin A and its metabolites in pancreatic beta-cell function. Vitamin A, through retinoic acid signalling via retinoid acid receptors (RAR) and retinoid X receptors (RXR), is known to upregulate insulin secretion from pancreatic beta cells (Brun et al., 2015). The interaction of retinol binding protein 4 (RBP4) with its receptors — including Toll-like receptor 4 (TLR4) — can also modulate insulin sensitivity at target tissues (Wolf, 2007). In the present study, the elevated glucose at 30 minutes in Phase 2 may reflect a transient amplification of the insulin secretory response to the glucose load, as enhanced insulin action would initially drive rapid glucose uptake but could subsequently induce a rebound rise in glucose through counter-regulatory mechanisms. This is further supported by the slight secondary rise at 120 minutes observed in Phase 2, before glucose fell to its nadir at 150 minutes.

These findings align with reports by Jeyakumar et al. (2017), who demonstrated that vitamin A improves hyperglycaemia and glucose intolerance in obese rat models through regulation of intracellular signalling and glycogen synthesis pathways. Similarly, Brun et al. (2015) demonstrated that all-trans retinoic acid (ATRA) signalling is essential for maintaining beta-cell mass and glucose-stimulated insulin secretion (GSIS). In diabetic mouse models, ATRA treatment restored islet vascularity and improved blood glucose through vascular endothelial growth factor-A (VEGF-A) production (Chien et al., 2016). The current findings in healthy volunteers suggest that even in non-diabetic subjects, supraphysiological doses of vitamin A acutely alter postprandial glycaemic dynamics, possibly by transiently potentiating insulin secretion.

In contrast, Phase 3 (glucose + vitamin C) produced a glucose tolerance curve that closely mirrored the control, with no statistically significant difference at any time point ($p > 0.05$). This is consistent with the known mechanism of vitamin C–glucose competition for cellular entry. Both glucose and ascorbic acid share similar molecular structures and compete for insulin-mediated membrane transport via glucose transporters (GLUTs) (Shukla et al., 2012). In the hyperglycaemic state created by the glucose challenge, glucose would be expected to competitively inhibit vitamin C uptake into cells. Conversely, the presence of vitamin C may not significantly impair glucose transport given the overwhelming molar excess of glucose administered (75 g). The lack of significant effect of vitamin C on the glucose curve may therefore reflect the kinetic dominance of glucose under experimental conditions, consistent with findings reported by Wesler and Bast (2010). Furthermore, vitamin C's known antioxidant activity — reducing free radical formation and enhancing insulin-mediated glucose transport — may have exerted a subtle buffering effect, as evidenced by the slight but non-significant delay in peak glucose time observed in Phase 3 (90 vs 60 minutes in other phases).

The combined supplementation group (Phase 4) exhibited the most protracted glucose curve, with a marked secondary rise at 120 minutes and the highest blood glucose value at 150 minutes among all groups. This finding is particularly novel and suggests a pharmacokinetic interaction between vitamins A and C that may modulate the rate of intestinal glucose absorption and subsequent tissue uptake. One plausible mechanism involves the synergistic modulation of RBP4 signalling and antioxidant pathways: while vitamin A upregulates insulin sensitivity-related cascades, vitamin C's competition for glucose transporters may delay overall glucose clearance in a manner not observed with either vitamin alone. This combined effect appears to produce a prolonged secondary hyperglycaemic excursion, which, if chronic, could have implications for individuals at risk of impaired glucose tolerance.

The study has several limitations that should be acknowledged. The sample was restricted to 20 healthy young females from a single university, limiting generalisability to older adults, males, or individuals with pre-existing metabolic disorders. The use of supraphysiological doses of vitamin A (100,000 IU) exceeds typical dietary or supplemental intake and may not reflect real-world supplementation practices. No plasma insulin, C-peptide, or oxidative stress markers were measured, which would have provided mechanistic insight into the observed glucose dynamics. Additionally, the absence of a formal washout period measurement and the lack of a randomised crossover design represent methodological limitations. Future studies should incorporate larger, mixed-gender samples, include hormonal and biochemical assays, and adopt doses reflective of standard supplementation guidelines.

Despite these limitations, this study is among the few to characterise the combined effects of vitamins A and C on postprandial glucose dynamics in a sub-Saharan African population, adding novel and clinically relevant data to the existing literature.

## V. CONCLUSION

This study demonstrates that oral vitamin A supplementation transiently amplifies the early postprandial glucose rise in healthy female volunteers, possibly through potentiation of pancreatic beta-cell insulin secretion. Vitamin C supplementation at 1,000 mg did not significantly alter the glucose tolerance curve compared to glucose alone, consistent with competitive but kinetically insignificant interference with glucose transport under hyperglycaemic conditions. The combined supplementation of vitamins A and C produced a prolonged secondary glucose rise at 120 minutes, suggesting a potential interactive effect on glucose absorption and disposal dynamics not observed with either vitamin individually.

These findings underscore the importance of considering micronutrient interactions when evaluating their

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metabolic effects. While supplementation with vitamins A and C in addition to a normal diet may ultimately support improved glycaemic control and plasma glucose management, clinicians and public health practitioners should be aware of the acute postprandial effects of high-dose vitamin A supplementation in healthy populations. Further research involving larger, randomised, controlled trials with mechanistic biomarkers is warranted to elucidate the precise pathways and establish evidence-based supplementation guidelines for glucose management.

➢ *Conflicts of Interest*

- The authors declare no conflicts of interest.

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## REFERENCES

[1]. Berlanga-Acosta, J., Lopez-Saura, P., Guillen-Pérez, I., Guillen-Nieto, G., Acevedo-Castro, B., & Herrera-Martinez, L. (2013). Type 2 Diabetes Mellitus (T2DM): Biological overview from pathways to organelles and its translation toward a torpid wound healing process. Journal of Diabetes and Metabolism, 4, 285–290.

[2]. Brazis, P. W. (2004). Pseudotumor cerebrospinal and current neurology and neuroscience reports. Current Neurology and Neuroscience Reports, 4(2), 111–116.

[3]. Brun, P. J., Grijalva, A., & Rausch, R. (2015). Retinoic acid receptor signaling is required to maintain glucose-stimulated insulin secretion and β-cell mass. FASEB Journal, 29(2), 671–683.

[4]. Carneiro, G., Laferrère, B., & Zanella, M. T. (2013). Vitamin and mineral deficiency and glucose metabolism — a review. e-SPEN Journal, 8, 73–79.

[5]. Chien, C. Y., Yuan, T. A., Cho, C. H., Chang, F. P., Mao, W. Y., & Wu, R. R. (2016). All-trans retinoic acid ameliorates glycemic control in diabetic mice via modulating pancreatic islet production of vascular endothelial growth factor-A. Biochemical and Biophysical Research Communications, 477(4), 874–880.

[6]. Christie-David, D. J., Girgis, C. M., & Gunton, J. E. (2015). Effects of vitamins C and D in type 2 diabetes mellitus. Nutrition and Dietary Supplements, 7, 21–28.

[7]. Güemes, M., Rahman, S. A., & Hussain, K. (2015). What is normal glucose? Archives of Disease in Childhood, 1, 1–6.

[8]. Inzucchi, S. E. (2012). Clinical practice: Diagnosis of diabetes. New England Journal of Medicine, 367(6), 542–550.

[9]. Jeyakumar, S. M., Sheril, A., & Vajreswari, A. (2017). Vitamin A improves hyperglycemia and glucose-intolerance through regulation of intracellular signaling pathways and glycogen synthesis in WNIN/GR-Ob obese rat model. Preventive Nutrition and Food Science, 22(3), 172–183.

[10]. Karolina, G., Aleksandra, D., Natalia, J., & Ewa, O. B. (2018). Considering the role of vitamin A in glucose metabolism. Journal of Endocrinology and Diabetes, 5(3), 1–5.

[11]. Kaufman, F. R. (2000). Role of the continuous glucose monitoring system in paediatric patients. Diabetes Technology and Therapeutics, 2(1), 49–52.

[12]. Mitrakou, A. (2011). Kidney: Its impact on glucose homeostasis and hormonal regulation. Diabetes Research and Clinical Practice, 93(1), 66–72.

[13]. Opara, E. C. (2004). Role of oxidative stress in the etiology of type 2 diabetes and the effect of antioxidant supplementation on glycaemic control. Journal of Investigative Medicine, 52(1), 19–23.

[14]. Shukla, A., Priyadarshini, S., & Qamar, I. (2012). Involvement of calcium and vitamin C in Type 2 diabetes mellitus. IOSR Journal of Pharmacology, 2, 9–20.

[15]. Trasino, S. E., Benoit, Y. D., & Gudas, L. J. (2015). Vitamin A deficiency causes hyperglycemia and loss of pancreatic β-cell mass. Journal of Biological Chemistry, 290(3), 1456–1473.

[16]. Wesler, A. R., & Bast, A. (2010). Oxidative stress and vascular functions: Implications for pharmacologic treatments. Current Hypertension Reports, 12, 154–161.

[17]. Wolf, G. (2007). Serum retinol-binding protein: A link between obesity, insulin resistance, and type 2 diabetes. Nutrition Reviews, 65(5), 251–256.

[18]. Johansen, J. S., Harris, A. K., Rychly, D. J., & Ergul, A. (2005). Oxidative stress and the use of antioxidants in diabetes: Linking basic science to clinical practice. Cardiovascular Diabetology, 4, 5.

[19]. Brun, P. J., Yang, K. J., Lee, S. A., Yuen, J. J., & Blaner, W. S. (2013). Retinoids: Potent regulators of metabolism. BioFactors, 39(2), 151–163.

[20]. Copeland, K. C., Silverstein, J., Moore, K. R., Prazar, G. E., Raymer, T., & Shiffman, R. N. (2013). Management of newly diagnosed type 2 diabetes mellitus (T2DM) in children and adolescents. Pediatrics, 131(2), 364–382.