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Effects of low-fat whole milk on postprandial glycemia after consumption of two common Ghanaian local meals among healthy young adults

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Abstract

Background: The addition of dairy products to a meal high in carbohydrates or fat may potentially result in reductions in acute postprandial glycemic responses. There is limited data on the postprandial effects of local Ghanaian meals and this potential role of milk in attenuating acute postprandial glycemia changes have not been previously tested among Ghanaians.

Objectives: The overall objective of the study is to determine the effects of low-fat whole milk on postprandial glycemia after consumption of two common Ghanaian local meals among healthy young adults.

Methods: The study included 10 healthy, non-obese young adults. Two common local Ghanaian meals (*Waakye and Ga Kenkey*) were consumed on separate days with water and low-fat whole milk. Glycemic responses were assessed at fasting and 30-minutes postprandial point intervals for 3 hours. Postprandial glycemia, was assessed by the incremental Area Under the Curve (iAUC). Percentage postprandial glycemia peak was assessed as the percentage glycemia difference between peak glycemia point and baseline. Percentage postprandial glycemia retention. Student t-test was used to compare differences in postprandial responses with and without milk.

Results: On consumption of *Waakye*, there were statistically non-significant decreases in mean postprandial iAUC, and percentage postprandial glycemia retention with low-fat whole milk. However, a relatively lower but statistically non-significant percentage postprandial glycemia peak was observed with the low-fat whole milk. With *Kenkey,* the results showed a relatively lower postprandial iAUC, percentage postprandial glycemia peak and percentage postprandial glycemia retention on consumption with the low-fat whole milk. However, these differences were not observed to be statistically significant.

Conclusion: There are variations in the effects of low-fat whole milk on postprandial glycemia response between different meal types. No statistically significant differences were observed in the effects of low-fat whole milk in limiting postprandial glycemia response in both test meals. The findings point to further research on the subject in different targeted populations, including type-2 diabetes mellitus (T2DM) clients.

Keywords: Fat-Restricted Diet, Milk, Postprandial period, Glycemic control, Meals.

Introduction

In Sub-Saharan Africa (SSA), Non-communicable diseases (NCDs) have accounted for a 67% increase in disability-adjusted life-years (DALY) and type-2 diabetes mellitus (T2DM) accounted for 126% increase in the DALY between the period of 1990 to 2017.[1] The regional prevalence of T2DM in SSA is reportedly 5.1%, which range from 2.6% to 22.5% across data from different regions in SSA.[2,3] Between 1990 and 2015, T2DM has accounted for 7% mortality rate attributed to NCDs in SSA.[4] Adoption of a nutritional approach could deliver a cost-effective T2DM prevention and management strategy, applicable across the population. However, to implement a successful strategy and provide clear

guidance, it will be essential to understand the effects of meal on the underlying metabolic derangements. Epidemiological studies suggest that chronically-high consumption of milk and milk products is associated with a reduced risk of T2DM.[5,6] Some previous intervention studies on the effects of dairy on postprandial metabolism indicate that milk elicits favorable effects on glucose metabolism both alone or with a meal.[7,8,9] The addition of dairy products to a meal high in carbohydrates or fat may potentially lessen the risk of T2DM through reductions in acute postprandial glycemic responses.[10-12] There is limited data on the postprandial effects of local Ghanaian meals and this potential role of milk in attenuating acute postprandial glycemia changes have not been previously tested among Ghanaians.

Objectives

The overall objective of the present study is to determine the effects of low-fat whole milk on postprandial glycemia after consumption of two common Ghanaian local meals among healthy young adults.

Methods

Study design

The experimental**,** cross-over trial study was conducted at Garden City University College, Kenyase in the month of March, 2023. The study included a convenient sample size of 10 healthy, non-obese young adults voluntarily selected from the student population. The exclusion criteria for participation were obesity**,** recent ailment, history of any chronic medical condition or medication, smoking, alcohol use, or history of gastrointestinal disease.

Meal types

Two common local Ghanaian meals were used for the study:

a. Ga Kenkey; 250g (fermented corn dough) + 150g (fried red fish) + 30g hot mixed vegetable sauce (hot chili pepper, green pepper, tomatoes, and onions).
b. Waakye; 250g (local rice and beans in the ratio of 90:10) + 30g *shito* (fried hot chili pepper sauce) and salad + 80g fried beef + 30g boiled egg.

Meal preparation

All the testing meals were prepared by the same accredited restaurant known to all the researchers and participants. The preparation methods and relative compositions of the macronutrients were done according to the usual daily procedures of the restaurant so that the meal appearance is exactly how they are known and consumed by all the researchers and study participants.

Study protocol

All testing was done at 2 days intervals. Subjects were advised to maintain their normal lifestyle throughout the study period and also consume the same diet (porridge and bread) as dinner before the day of testing. On each testing day, fasting blood glucose was first measured with a glucometer (Accu-Chek™) to serve as baseline glycemia.

All subjects consumed the total amount of the prepared meal within 10 minutes with 750ml of distilled water. Subjects were made to be at rest with limited physical activity. Blood glucose was measured with the glucometer at 30 minutes intervals for 3 hours. The whole procedure was replicated after 2 days with substitution of the distilled water with 750ml of low-fat whole milk. The protocol was tested for the 2 meals on separate weeks.

Outcome variables

Postprandial glycemia was assessed by the incremental Area Under the Curve (iAUC). Percentage postprandial glycemia peak was assessed as the percentage glycemia difference between peak glycemia point and baseline. Percentage postprandial glycemia retention was determined as difference between glycemia at end-point and baseline.

Statistical analysis

Continuous variables were presented as mean ± standard deviation. Student's t-test was used to compare differences in postprandial responses with and without milk. All statistical analyses were performed with SPSS (version 16.0, SPSS Inc, Chicago, IL, USA). A "P-value" less than 0.05 was considered significant.

Ethical considerations

All procedures were conducted under written informed consent following the ethical statutes of the Declaration of Helsinki. The study was approved by the Committee on

Human Research, Publication and Ethics of Kwame Nkrumah University of Science and Technology.

Results

Table 1 presents the general characteristics of the study population. The study included 10 healthy young non-obese adults with a mean age of 23.0 ± 1.3 years.

Table 1. General characteristics of the study population

Parameter	Mean±SD
Age (years)	23.0 ± 1.3
BMI (Kg/m^2)	23.5 ± 1.1
Fasting plasma glucose (mmol/l)	4.8 ± 0.3

Results are presented as mean ± standard deviation

Tables 2 and 3 show the postprandial glycemic responses upon consumption of *Waakye*. On consumption of *Waakye*, there were statistically non-significant increase in mean postprandial iAUC, and percentage postprandial glycemia retention with the low-fat whole milk. However, a relatively lower but statistically non-significant percentage postprandial glycemia peak was observed with the low-fat whole milk.

Tables 4 and 5 show the postprandial glycemic responses upon consumption of *Ga Kenkey*. With *Kenkey,* the results showed a relatively lower postprandial iAUC, percentage postprandial glycemia peak and percentage postprandial glycemia retention on consumption with the low-fat whole milk. However, these differences were not observed to be statistically significant.

Table 2. Effects of low-fat whole milk on postprandial glycemia iAUC of *Waakye*

Subject	Waakye with water	Waakye with milk	p-value
01	312.0	319.5	
02	258.8	256.5	
C	106.5	108.0	
D	228.0	174.0	
E	274.5	223.5	
F	129.0	238.5	
G	243.0	258.0	
H	166.5	139.5	
I	351.0	264.0	
J	250.5	393.0	
Mean iAUC	232.0 ± 77.6	237.5 ± 83.7	0.881

Results are presented as means ± standard deviation

Table 3. Effects of low-fat whole milk on postprandial percentage glycemia peak and percentage glycemia retention with *Waakye*

Postprandial glycemia	Waakye with water	Waakye with milk	p-value
Percentage postprandial glycemia peak	46.6 ± 13.3	43.6 ±15.9	0.685
Percentage postprandial glycemia retention	17.3 ± 11.2	20.7 ± 9.3	0.470

Results are presented as mean ± standard deviation in percentages.

Table 4. Effects of low-fat whole milk on postprandial glycemia iAUC of *Kenkey*

Subject	Kenkey with water	Kenkey with milk	p-value
01	136.5	81.7	
02	187.5	210.0	
C	151.5	141.0	
D	154.5	228.0	
E	68.3	106.5	
F	115.5	160.5	
G	246.0	93.5	
H	226.5	64.5	
I	243.0	157.5	
J	204.0	162.0	
Mean iAUC	232.0 ± 77.6	140.5 ± 54.0	0.209

Results are presented as mean ± standard deviation

Table 5. Effects of fluid milk on postprandial percentage glycemia peak and percentage postprandial glycemia retention with *Kenkey*

Postprandial glycemia	Kenkey with water	Kenkey with milk	p-value
Percentage postprandial glycemia peak	36.6 ± 11.9	28.2 ± 14.4	0.173
Percentage postprandial glycemia retention	14.5 ± 10.8	12.3 ± 17.0	0.735

Results are presented as mean ± standard deviation in percentages.

Discussion

The overall aim of the present study is to determine the effects of low-fat whole milk on postprandial glycemia after consumption of two common Ghanaian local meals among healthy young adults. On consumption of *Waakye*, there were statistically non-significant reductions in mean

postprandial iAUC, and percentage postprandial glycemia retention with low-fat whole milk. However, a relatively lower but statistically non-significant percentage postprandial glycemia peak was observed with the low-fat whole milk. With *Kenkey,* the results showed a relatively lower postprandial iAUC, percentage postprandial glycemia peak and percentage postprandial glycemia retention on consumption with the low-fat whole milk. However, these differences were not observed to be statistically significant. Low-fat milk has previously been reported to reduce post-meal peak blood glucose concentration and post-meal glucose area under the curve (AUC) compared with water, soy beverage, 1% chocolate milk, orange juice, or a cowmilk-based infant formula.[7-9] However, the majority of intervention studies examining postprandial metabolism and dairy have usually employed milk-derived proteins, specifically whey protein. The incremental AUC for glucose decreased in a dose-dependent manner with the highest dose of whey protein supplement having a significantly greater effect than lower doses on postprandial hyperglycemia from a glucose drink.[13] Similarly, increasing doses of whey protein (10–40g) pre-meal reduced post-meal blood glucose and insulin AUC in a dose-dependent manner.[14] The combination of whey protein and carbohydrate intake results in increased plasma insulin and reduced plasma glucose concentrations compared with those consuming carbohydrate alone.[15] The addition of whey protein to a high glycemic meal for breakfast and lunch increases plasma insulin concentration by 31% at breakfast and 57% at lunch compared with meals without whey. Further, the consumption of whey decreases postprandial plasma glucose concentration by 21% compared with the meal without whey. A study on individuals with type 2 diabetes who consumed 50 g of whey or placebo with a high glycemic breakfast found that glucose levels were reduced 28% and insulin increased 105% after the protein preload.[16] Interestingly, while not compared in a head-to-head fashion, the decrease in glycemia was a larger reduction than that observed after different doses of a rapid-acting non-sulfonylurea insulin secretagogue.[17] Taken together, whey protein consumption both in healthy and diabetic individuals appears to attenuate the rise in postprandial glycemia when combined with a high-carbohydrate load. Overall, the postprandial glycemic effects of fluid whole milk showed subtle differences between the test meals. Though no significant differences were observed with *Waakye*, the results for *Kenkey* tend to point to a relatively lower postprandial glycemia exposure with the whole milk.

Although, the exact mechanisms underlying the previous favorable effects on postprandial glycemia are yet to be fully elucidated, suggested potential sources include the insulinotropic actions of some milk bioactive constituents.[18] However, some have suggested that the postprandial effects may be observed independent of insulin.[19] Dairy's bioactive compounds, in particular whey amino acids, appear to act on incretin hormones via bioactive peptides and amino acids released during digestion. Several gut hormones are stimulated (e.g., cholecystokinin, peptide YY) that increase insulin secretion while others serve as endogenous inhibitors (e.g., dipeptidylpeptidase-4) preventing incretin degradation.[20,21]

In general, the findings of the study tend to suggests a potential effect of low-fat whole milk in limiting postprandial glycemia response and, that these potential beneficial effects may vary between different meal types. A striking note is the observation that in the present study, these differences were not statistically significant. Possible factors that may account for this include the relatively small sample size, and the fact that all the participants were healthy non-obese young adults. These may serve as limitations of the study and therefore generalization of the results should be done with caution. However, the findings point to increased further research on the subject in different targeted populations, including T2DM clients with important implications for medical nutritional therapy.

Conclusions

No statistically significant differences were observed in the effects of low-fat whole milk in limiting postprandial glycemia response in both test meals. However, in general, the findings of the study tend to suggests potential effects of low-fat whole milk in limiting postprandial glycemia response and, that these potential beneficial effects may

vary between different meal types. The findings point to increased further research on the subject in different targeted populations, including T2DM clients.

Acknowledgment

We are very much grateful to all participants for their voluntary participation.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

Saharan Africa: SSA; Non-communicable diseases: NCDs; Disability-adjusted life-years: DALY; Type-2 diabetes mellitus: T2DM; Incremental Area Under the Curve: iAUC.

Authors' contributions

QP conceived the original idea. QP and OAB designed the study. AG, AL, NM and AK worked on data collection. QP analyzed the data. AG, AL, NM and AK prepared the original draft. QP and OAB prepared the final draft. All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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Availability of data and materials

The data used in this study are available from the corresponding author on request.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. Institutional Review Board approval was obtained.

Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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