Research Article

SCISET
www.sciset.com

Journal of Nutrition, Dietetics & Nutraceuticals

2023
Vol. 1 No. 1: 101

Assessing Glycemic Responses to Low-Fat Milk Enriched with Whey Proteins and Oats Powder

Manokaran S[1], Jayasinghe MA[1*], Senadheera AS[2], Gunathilaka SS[3]

[1]Department of Food Science & Technology, Faculty of Applied Sciences University of Sri Jayewardenepura, Sri Lanka.
[2]Department of Biochemistry, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka, Sri Lanka.
[3]Department of Microbiology, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka, Sri Lanka.

Corresponding author:
Jayasinghe MA, Department of Biochemistry, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka, Sri Lanka. E-mail: Madhura.j@sci.sjp.ac.lk

Abstract

This study investigates the glycemic responses of low-fat milk incorporated with whey proteins and oats powder through a randomized crossover design. Eleven healthy volunteers (6 males, and 5 females, aged 20-30 years, BMI 18.5-23.5) ingested a formulation consisting of skimmed milk powder, additional whey proteins, and oats flour (4:1 ratio) with 50 g of available carbohydrates. Blood glucose concentrations were measured at various intervals, revealing a glycemic index (GI) of 12 ± 2 and a 37.7% average peak reduction compared to the standard (Glucose). Proximate analysis indicated higher total protein content (36.08 ± 2.5%) and lower fat content (4.34 ± 0.5%) compared to fresh milk powder. The incorporation of whey powder significantly reduced the GI of milk ($p<0.05$), suggesting the potential development of low-GI milk powder formulations by incorporating whey proteins and cereal grains like oats.

Keywords: Glycaemic index; Low-fat milk; Whey proteins; Oats; Randomized crossover study

Citation: Manokaran S, Jayasinghe MA, Senadheera AS, Gunathilaka SS. (2023) Assessing Glycemic Responses to Low-Fat Milk Enriched with Whey Proteins and Oats Powder. J Nutr Diet Nutraceuticals. Vol 1(1): 101.

Received: February 20, 2023; **Accepted:** March 16, 2023; **Published:** March 23, 2023

Introduction

In the contemporary landscape, approximately 17% of the global population is believed to grapple with diabetes and related non-communicable diseases, primarily stemming from unhealthy dietary practices [1]. Diabetes, a non-communicable ailment characterized by a persistent and habitual increase in blood glucose levels, has prompted the widespread utilization of concepts like Glycemic Index (GI) and glycemic load to assess the impact of food sources on postprandial glucose levels.

Several factors influence the GI of food, and recent research suggests that specific milk proteins possess insulinotropic properties, potentially significantly elevating postprandial insulin levels [3]. Ercan's findings indicate a reduction in glucose response when a moderate amount of fat is ingested concurrently with carbohydrates [4].

Despite concerns leading some individuals to avoid dairy due to perceived associations with obesity, osteoarthritis, and cardiovascular diseases, research by Serge Roz Enberg et al. contradicts this belief, asserting that dairy products, particularly when low in fat, do not increase the risk of cardiovascular diseases [5].

This study is centered on examining the glycemic responses of milk powder with reduced fat and increased whey proteins. Many commercially available high-protein dairy-based powder formulations are laden with additional calorie contributors such as fats and carbohydrates. While these products offer high protein content, their potential to elevate blood glucose levels, when consumed regularly, may pose a risk of pre-diabetic conditions.

To address this, cow milk was reformulated and standardized, reducing its fat content. The resulting product is a low-fat, high-protein dietary option.

Given the prevalent practice of adding sugar (sucrose) to milk powder, especially in Asian cultures like Sri Lanka, the formulated milk powder must have an initially low Glycemic Index. This ensures that the addition of sugar does not substantially increase glycemic responses.

Both proteins and fats in food are recognized for their ability to reduce blood glucose elevations [6]. However, it remains unclear which component—milk whey proteins or milk fat—has a greater impact on reducing the Glycemic Index in dairy sources. Therefore, this study aims to provide insights into the comparative and practical effects of milk whey proteins and milk fat on glycemic responses.

Materials and Methods

Materials

- Cow milk (15 L) with reduced fat (5.31%) was spray-dried to achieve a moisture content of 3.5%.
- Oats powder and whey protein powder from reputable commercial brands were ground to a fine powder (particle size 0.05–0.01 mm).
- For 100 g of milk powder, 20 g of whey and 10 g of oats powder were blended.

Preparation of Breakfast Meals

- Skimmed milk powder, powdered oats, and whey were mixed in ratios determined by a palatability test conducted by a non-trained panel.

Analysis of Proximate Composition

- Proximate compositions of the powder mixture were determined:
- Moisture and ash contents by AOAC official methods [7,8].
- Digestible carbohydrate content, fat, and soluble & insoluble dietary fiber with Holm's method [9], Croon and Guchs [10], and Asp's method [11], respectively.
- Crude protein using the Kjeldahl method with Copper/ Selenium catalysts [12].

Ethical Clearance

- Ethical clearance (No.77/17) was obtained from the Ethical Review Committee, Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka.
- Informed written consent was obtained from all participating subjects.

Determination of Glycaemic Indices

- A randomized crossover study, following Brouns et al.'s review in 2005 [13].
- Healthy volunteers (n=11), both sexes (6 males, 5 females), aged 20-30, BMI 18.5-23.5.
- Subjects refrained from smoking, alcohol, and vigorous physical activities the day before.
- Glucose (GI=100) was served as the standard; test and standard foods (50 g digestible carbohydrates) were served randomly to the same individual on separate occasions.
- Capillary blood samples were collected at 30, 45-, 60-, 90-, and 120-min post-meal.
- Serum glucose concentrations were determined with a Glucose-Oxidase kit (BIOLABOSATM; Biolabosa, France).
- GI calculated using the meaning of individual incremental area under the curve of the test and standard foods [13].
- Glycaemic load (GL) of the test food calculated (GL = GI*digestible starch per serving (g))/100).

Statistical Analysis

- Proximate composition values expressed as mean ± standard deviation.
- GI values expressed as mean with SEM.
- Comparison of GI values of the test food with typical cow milk using paired Student's t-test (Microsoft Excel 2013) at a 95% confidence level.

Results

Proximate Compositions

Proximate compositions of fresh cow milk powder and the newly formulated powder sample are depicted in Figure 1. Significant differences ($p<0.05$) were observed in all three macronutrient contents (fat, protein, digestible carbohydrates) between the two samples. Crude fiber contents in both samples were not measurable, with the remainder considered mineral ash.

Glycemic Index (GI)

The GI for the prepared formulation was 12 ± 2 (Low GI), significantly ($p<0.05$) lower than the reported GI of fresh milk (36, as found by David et al. [14]). This substantial threefold reduction in GI in the new powder formulation was achieved through the incorporation of whey and oats powder, replacing a significant amount of milk fat.

Blood Glucose Peaks

The average maximum peak value for glucose was 162.7, while the newly formulated powder exhibited a considerably reduced

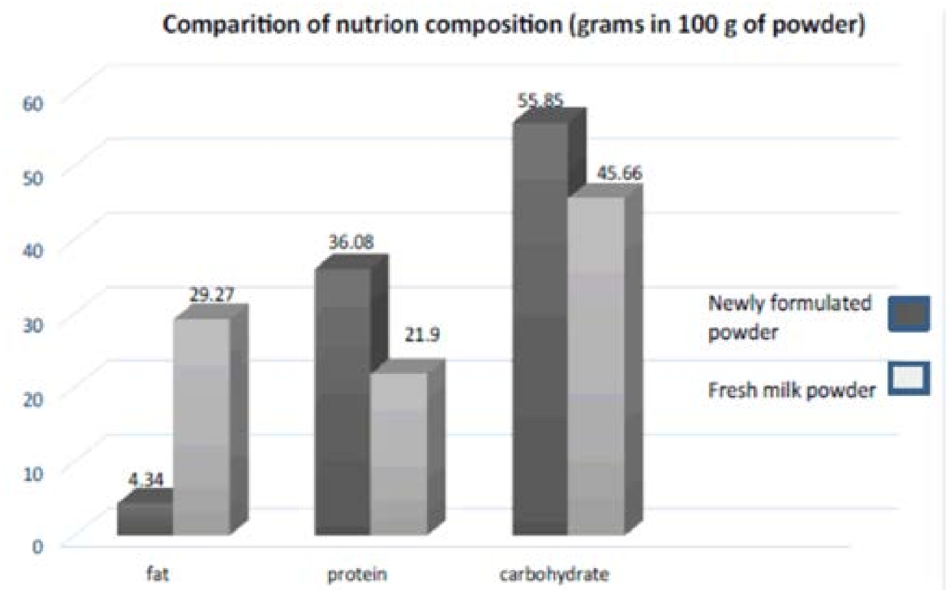

Figure 1: Comparison of macronutrient composition between fresh milk and newly formulated powder product.

Table 1: Average blood glucose values with time.

Food	0 min	15 min	30 min	45 min	60 min	90 min	120 min
Standard (Glucose)	93.4	128.7	151.9	162.7	137.2	120.5	96.5
Formulated sample	92.4	99	101.3	95.8	95.3	97.4	93.1

Table 2: Detailed glycemic response results in newly formulated powder.

Mean GI	12 ±2
Standard error mean	1.7
Portion size	350 mL
Peaking time	30 min.
Peak reduction	61.4 mg/dL
% Peak Reduction (compared to Glucose)	37.73
% GI reduction (Compared to fresh milk)	66.7
Glycaemic Load	2.3

peak of 101.3 (Table 1). This represents a notable peak reduction of 37.73% (Table 2).

Glycemic Response Curve

The glycemic response curve of the prepared powder formulation (Figure 2) indicated a lower peak value compared to the standard (Glucose). The peaking time was observed 15 minutes earlier than glucose (Figure 2).

Glycemic Load (GL)

According to the Glycemic Load scale, GL values ≥ 20 are considered high, between 11 to 19 as intermediate, and GL ≤ 10 as low. The calculated GL value for the formulated powder sample was 2.3 (Table 2), indicating a very low GL value.

Discussion

The significant reduction in the Glycemic Index (GI) observed in

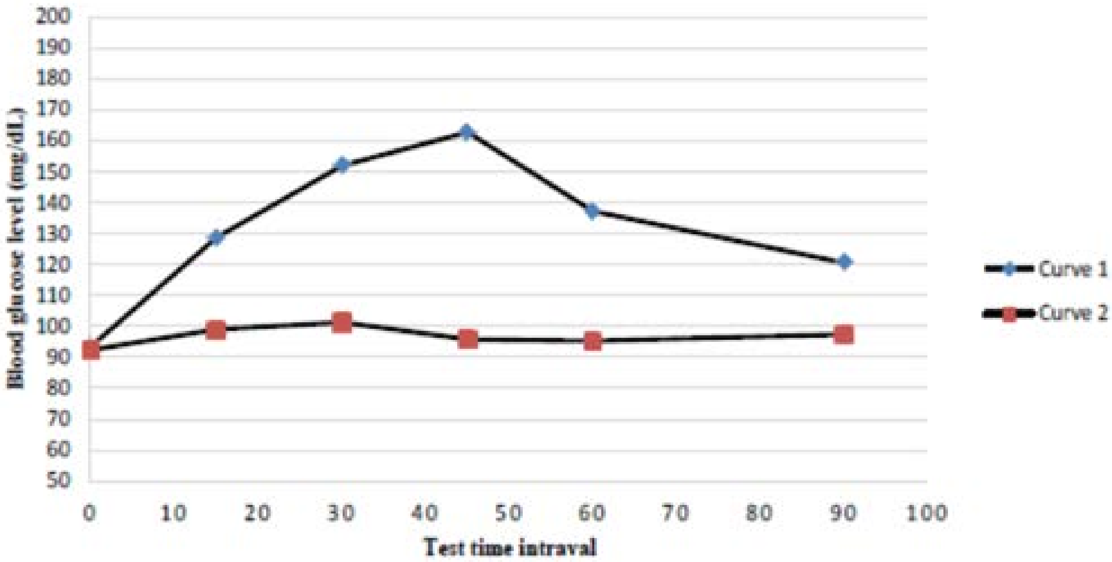

Figure 2: Blood glucose response curves (Glucose vs. formulated sample).

the newly formulated powder compared to fresh milk suggests a substantial impact of whey proteins in diminishing glycemic responses. Although the digestible carbohydrate content increased due to the incorporation of oats powder, fat reduction, a known factor for lowering GI, outweighed this effect in the new formulation. Proximate analysis results did not indicate a considerable contribution of dietary fiber from oats powder, emphasizing the pivotal role of whey proteins in the observed GI reduction [14].

Cow milk is rich in essential nutrients crucial for maintaining a healthy lifestyle, and a dairy-free diet may pose challenges in meeting nutritional requirements. Despite this, the prevalent practice of adding sugar to milk, especially in Asian cultures like Sri Lanka, necessitates efforts to minimize the initial GI of milk.

This study explores the combined impact of reducing fat, increasing whey proteins, and incorporating cereals like oats on the glycemic response of milk. The findings highlight that the substantial inclusion of whey proteins can counteract the potential GI increase resulting from both increased digestible carbohydrate content and reduced fat.

Glycemic Load (GL) considerations provide insights into the likely glycemic effects of realistic portion sizes of different foods. Volunteers noted that the portion size of the newly formulated powder product appeared 'larger.' Consequently, the GL value for the powder formulation may be lower when accounting for actual daily consumption.

The study underscores the noteworthy negative impact of whey proteins on blood glucose elevations, surpassing the impact of milk fat content. These findings hold significance for dairy powder producers, offering insights into formulating products with reduced fat and increased whey proteins to mitigate glycemic impact.

Conclusion

In conclusion, whey protein emerges as a pivotal factor in reducing the glycemic responses of milk, effectively counteracting the potential increase in GI due to reduced fat and a slight increment in digestible carbohydrates from cereals like oats. This valuable information can guide industrial producers in formulating low-fat, high-protein milk powder products, catering to the growing demand for healthier dairy options.

Conflict of Interest

No conflicts of interest have been declared.

References

1. American Diabetes Association (2013) Standards of medical care in diabetes.

2. Bell KJ, Smart CE, Steil GM, Brand-Miller JC, King B, et al. (2015) Impact of fat, protein, and glycemic index on postprandial glucose control in type 1 diabetes: implications for intensive diabetes management in the continuous glucose monitoring era. Diabetes Care 38: 1008-1015.

3. Nilsson M, Stenberg M, Frid AH, Holst JJ, Bjorck IM (2004) Glycemia and insulinemia in healthy subjects after lactose-equivalent meals of milk and other food proteins: the role of plasma amino acids and incretins. Am J Clin Nutr 80: 1253-1246.

4. Ercan N, Gannon MC, Nuttall FQ (1994) Effect of added fat on the plasma glucose and insulin response to ingested potato given in various combinations as two meals in normal individuals. Diabetes Care 17: 453-459.

5. Rozenberg S, Body JJ, Bruyère O, Bergmann P, Brandi ML, et al. (2016) Effects of dairy products consumption on health: benefits and beliefs-a commentary from the Belgian Bone Club and the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases. Calcif Tissue Int98: 1-17.
6. Moghaddam E, Vogt JA, Wolever TM (2006) The effects of fat and protein on glycemic responses in nondiabetic humans vary with waist circumference, fasting plasma insulin, and dietary fiber intake. J Nutr 136: 2506-2511.
7. Association of Official Analytical Chemists (1984) Official Methods of Analysis of the AOAC 1984. 14th edition AOAC: Washington DC, 7.009.
8. Association of Official Analytical Chemists (1984) Official Methods of Analysis of the AOAC 14th edition. AOAC: Washington DC, 14.004.
9. Holm J, Drews A, Asp NG (1986) A rapid method for the analysis of starch. Starch/Starke 38: 226-224.
10. Croon LB, Guch G (1980) Crude fat analysis of different flours and flour products. Var Foda32: 427-425.
11. Asp NG, Johansson CG, Hallmer H, Siljestrom M, et al. (1983) Rapid enzymatic assay of insoluble and soluble dietary fiber. J Agr Food Chem 31: 478-476.
12. Association of Official Analytical Chemists (1987) Official Methods of Analysis of the AOAC. Washington DC 7.033.
13. Brouns F, Bjorck I, Frayn KN, Gibbs AL, Lang V, et al. (2005) Glycaemic index methodology. Nutrition Research Reviews18: 171-145.
14. Jenkins DJ, Wolever TM, Taylor RH, Barker H, Fielden H, et al. (1981) Glycemic index of foods: a physiological basis for carbohydrate exchange. Am J Clin Nutr 34: 362-366.