IMPACT OF A CARBOHYDRATE-RICH DIET ON GUT MICROBIOTA COMPOSITION AND ENTEROCOCCAL DYNAMICS

Victoria BOGDAN*
Institute of Physiology and Sanocreatology of the State University of Moldova, Chișinău, Republic of Moldova
*Corresponding author: victoria.bogdan@sti.usm.md

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ABSTRACT

Excessive consumption of refined carbohydrates from processed foods is increasingly associated with intestinal dysbiosis and metabolic disturbances. The present study aimed to evaluate the impact of a carbohydrate-rich diet, using processed white bread as the main source, on the dynamics of enterococci in comparison with beneficial bacteria (bifidobacteria and lactobacilli) and opportunistic *Escherichia coli* in an experimental animal model. Laboratory rats were divided into control (standard diet) and experimental groups (high-carbohydrate diet), and intestinal bacterial counts were assessed at baseline, after 5, 10, and 15 days of dietary intervention, and following a 7-day recovery period. Microbial populations were quantified and expressed as log CFU/g. The high-carbohydrate diet induced a significant reduction in enterococci (up to 21%) and bifidobacteria (up to 22.2%), accompanied by a moderate decrease in lactobacilli and an increase in *E. coli* populations during the early phase of intervention. Restoration of the standard diet partially or completely reestablished microbial balance. These findings suggest that processed carbohydrate excess disrupts intestinal microbial homeostasis, highlighting the sensitivity of enterococci to dietary carbohydrate shifts and supporting their potential commensal role in gut ecosystem stability.

Keywords: intestinal dysbiosis, dietary intervention, microbial balance, commensal bacteria, Escherichia coli, bifidobacteria, lactobacilli

1. INTRODUCTION

In recent scientific literature, the term “industrialized gut microbiota” is increasingly used to describe a bacterial community characterized by a reduced capacity to degrade dietary fiber and by shifts in microbial composition associated with modern lifestyle and dietary changes (Adolph et al., 2022). Increased consumption of simple carbohydrates and processed foods is considered an important factor contributing to the development of this type of microbiota. Studies indicate that high intake of glucose and fructose is associated with alterations in gut microbial composition and with the development of metabolic disorders, including non-alcoholic fatty liver disease (Garcia et al., 2022; Zhang et al., 2025).

A diet rich in refined carbohydrates may promote intestinal dysbiosis, characterized by a reduction in beneficial bacteria and proliferation of potentially pathogenic microorganisms (Yang & Kweon, 2016). Frequent consumption of processed products, such as bread made from refined flour, has been associated with changes in gut microbiota composition and impairment of intestinal barrier function (Wang et al., 2023).

The physiological role of enterococci under conditions of excessive carbohydrate intake remains insufficiently elucidated, although their ability to metabolize a wide range of carbohydrates provides them with an ecological advantage in the gastrointestinal tract (Ramsey et al., 2014).

In this context, the aim of the present study was to evaluate the effect of processed foods, represented by bread, on enterococcal populations in comparison with beneficial bacteria (lactobacilli and bifidobacteria) and with *Escherichia coli*.

2. MATERIALS AND METHODS

The experiment evaluated the effect of a carbohydrate-rich diet on the animal organism. In this dietary model, carbohydrates were administered in proportions exceeding physiological requirements. The percentage composition of the principal nutrients in the experimental diets is presented in Table 1.

Table 1. Percentage composition of nutrients in the experimental diets

Principal nutrients	***Standard diet (%)***	***High-carbohydrate diet (%)***
Proteins	14,88	13,4
Lipids	2,9	2,11
Carbohydrates	82,2	84,5

Due to the exploratory nature of the study, a limited number of animals was used; all animals were housed individually in separate cages. The animals were divided into two groups: control animals (Lots I and II), receiving the standard diet, and experimental animals (Lots III and IV), receiving the high-carbohydrate diet. The experimental diet was based primarily on processed white bread as the main carbohydrate source.

Intestinal microbiota dynamics were evaluated at baseline (prior to diet administration), after 5, 10, and 15 days of dietary intervention, and after a 7-day recovery period following the return to the standard diet.

Microbiological analyses were performed using selective culture media: Bile-Esculin Azide Agar (Himedia, M4931) for *Enterococcus spp.*, Bifidobacterium Agar (Himedia, M1396) for bifidobacteria, MRS Agar (Himedia, M641) for lactobacilli, and Endo Agar (Himedia, M029R) for *Escherichia coli*. All determinations were carried out in triplicate according to the SM EN ISO 4833-1:2014 standard. Microbial counts were calculated per gram of intestinal content and expressed as decimal logarithms (log CFU/g).

3. RESULTS AND DISCUSSION

Processed white bread was used as the primary source of dietary carbohydrates in the experimental diet (Figures 1–4).

The high-carbohydrate diet exerted an inhibitory effect on enterococcal populations. After 5 days of diet administration, enterococci decreased by approximately 14.6–16.2%. The most pronounced reduction was observed after 10 days, when the enterococcal population declined by 19.7–21% compared with baseline values. After 15 days, the decrease became less pronounced (11.1–14.9%), suggesting partial microbial adaptation to the dietary conditions (Figure 1).

These observations indicate that enterococci are sensitive to changes in carbohydrate intake, particularly during the initial stages of dietary intervention. Restoration of the standard diet resulted in the recovery of enterococcal populations to levels comparable to those recorded before the experiment.

To better understand the role of enterococci in intestinal microbial balance, changes in the populations of bifidobacteria and lactobacilli (beneficial bacteria) and *Escherichia coli* (representing opportunistic microorganisms) were also analyzed.

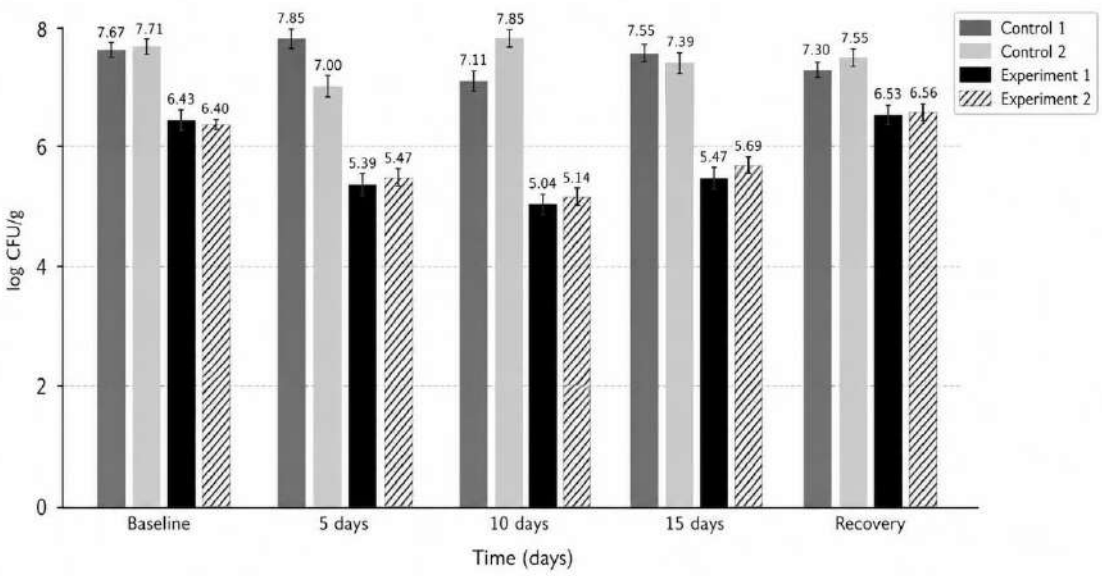


Figure 1. Dynamics of *Enterococcus* spp. (log CFU/g) in intestinal content during a high-carbohydrate diet and recovery period.

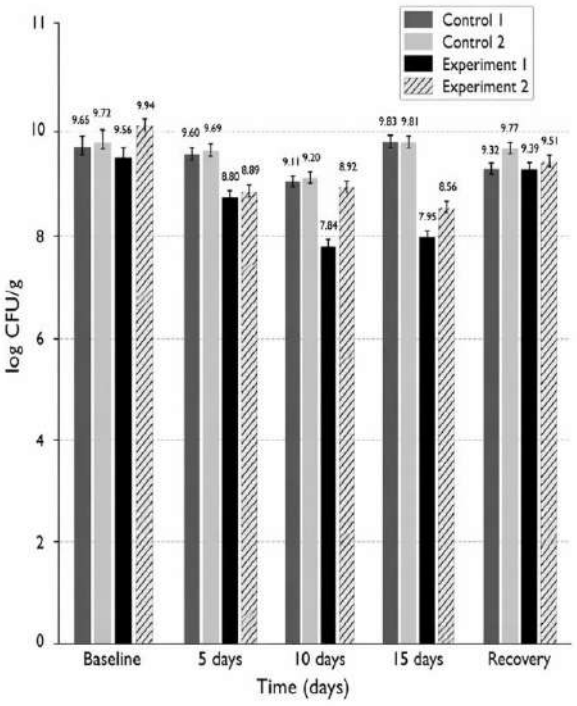


Figure 2. Dynamics of ***Lactobacillus* spp.** (log CFU/g) in intestinal content during a high-carbohydrate diet and recovery period.

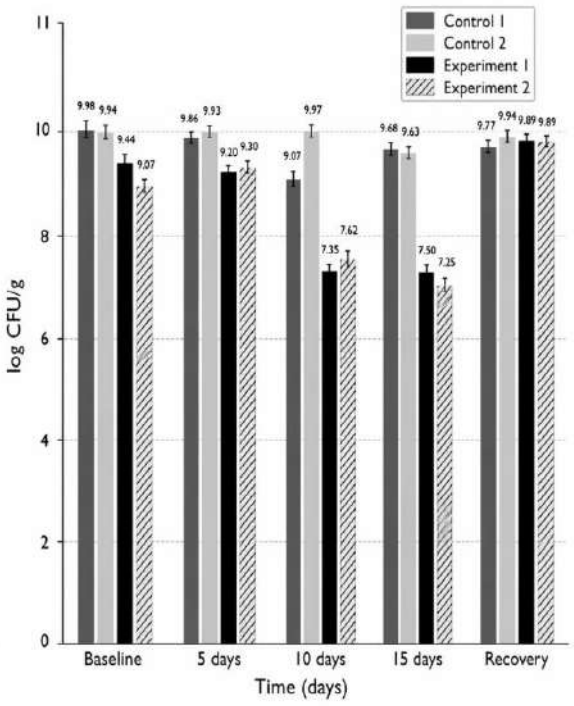


Figure 3. Dynamics of ***Bifidobacterium* spp.** (log CFU/g) in intestinal content during a high-carbohydrate diet and recovery period.

Bifidobacteria and lactobacilli appeared less sensitive than enterococci during the early phase of the experiment. After 5 days of carbohydrate-rich feeding, bifidobacteria decreased by 2.6–2.7%, while lactobacilli decreased by 7.9–10.6%. However, after 10 days, a more pronounced reduction in bifidobacteria was observed (21.4–22.2%), while lactobacilli decreased by 10.3–18.0% compared with baseline values (Figures 2-3).

After 15 days of dietary intervention, bifidobacteria remained approximately 20% lower than the initial levels, while lactobacilli showed a reduction of 13.9–16.8%. Return to the standard diet led to restoration of bifidobacterial populations to levels comparable to the control group, while lactobacilli also returned to values similar to those recorded before the experimental diet.

In contrast, the carbohydrate-rich diet promoted an increase in *Escherichia coli* populations. After 5 days, the number of *E. coli* increased by 10.6–10.9%, followed by smaller increases after 10 and 15 days (1.9–3.9% and 5.5–6.7%, respectively) (Figure 3).
The restoration of the standard diet resulted in a reduction of *E. coli* populations by 6.0–9.4% compared with baseline values and lower levels than those observed in the control group.
Overall, the results demonstrate that excessive intake of refined carbohydrates derived from processed bread alters the composition of intestinal microbiota by decreasing beneficial bacterial populations and promoting the proliferation of opportunistic microorganisms. These findings are consistent with previous studies indicating that diets rich in refined carbohydrates contribute to intestinal dysbiosis and metabolic disturbances.
The synchronous variation observed between enterococci and beneficial bacteria suggests a commensal ecological role of enterococci within the intestinal microbiota, supporting their potential involvement in maintaining microbial balance under normal dietary conditions.

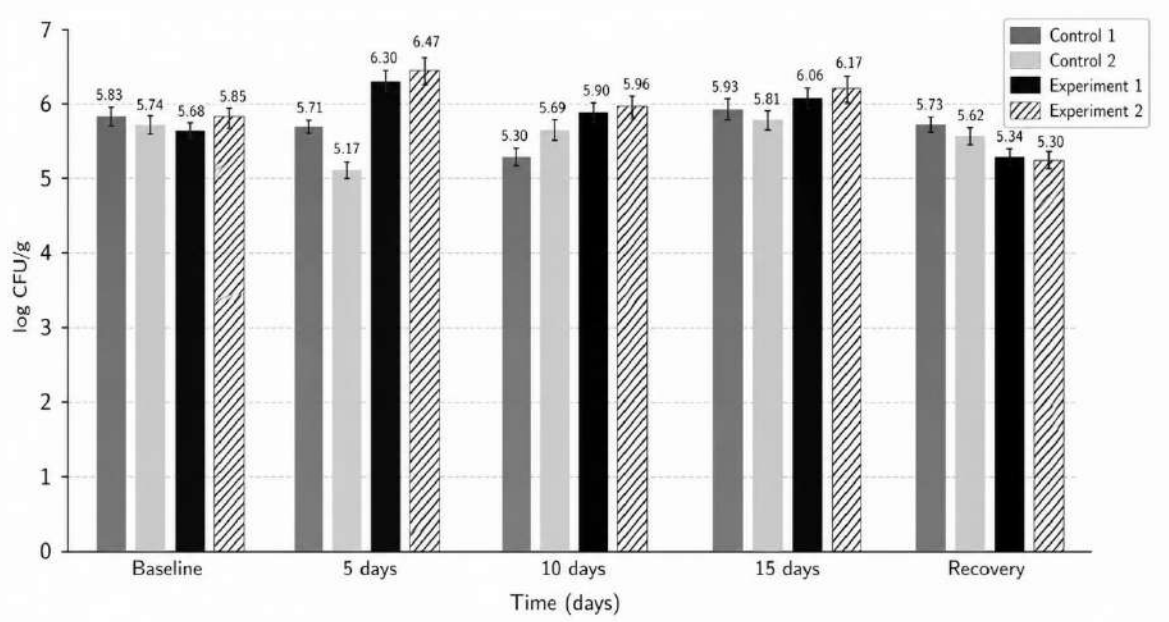


Figure 4. Dynamics of *Escherichia coli* (log CFU/g) in intestinal content during a high-carbohydrate diet and recovery period.

4. CONCLUSIONS

Excessive intake of refined carbohydrates from processed bread leads to a reduction in enterococci and beneficial bacteria (bifidobacteria and lactobacilli), along with an increase in *Escherichia coli*, indicating disruption of intestinal microbial balance.
Enterococci demonstrated sensitivity to changes in dietary carbohydrate intake, supporting their potential commensal role in maintaining gut microbiota stability.
Although beneficial bacteria exhibit a certain degree of resilience, prolonged exposure to excessive carbohydrates reduces their populations and may promote intestinal dysbiosis.
Restoration of a standard diet partially or completely reestablishes microbial balance, demonstrating the capacity of the gut microbiota to recover after diet-induced disturbances.

DECLARATIONS

Ethics Statement: The experiment was conducted in accordance with institutional guidelines for the care and use of laboratory animals.

Confirmation of originality: The author declares that this manuscript is original, has not been published previously, and is not under consideration for publication elsewhere.

Data Availability Statement : The datasets generated during the current study are available from the corresponding author upon reasonable request.

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