This month's issue features emulsifiers in alternative milks and the IMGC Symposium.

**Milk Science Collaboration Leads the Way**

- A change in scientific research is revolutionizing the discovery process.
- Large scientific collaborations are increasingly tackling the bigger and more complex aspects of nature.
- Dairy scientists had more collaborations and much greater productivity after they attended the annual meeting of the International Milk Genomics Consortium.

During the last two decades, there has been a revolution in the way science is undertaken. The minor discoveries in the past, such as the earth revolving around the sun, \( E=mc^2 \), the discovery of penicillin, and the gene basis to hereditary, were originally made by inspired individuals largely acting in isolation. They saw what no one else could see. The iconic public image of these scientists highlights their unkempt appearance and seeming disconnect with the immediate world mirroring a solitary mind languishing in abstract places. All that has now changed. Collaboration on the scale of the consortium now rules the scientific roost, as it accelerates the discovery process. At its heart, collaboration is the brewing pot for new ideas. Why is this important? New ideas lead to innovation, which is the fuel for large increases in industry productivity, the birth of new industries, and major societal advances. But how do you measure the success of collaboration?

Kwok and five colleagues from the University of California in Davis and the California Dairy Research Foundation recently published an intriguing analysis of collaborations, research output, and research impact associated with an annual scientific meeting focused on milk and held over a 12-year period (1). The meeting was promoted by the International Milk Genomics Consortium (IMGC) to better understand milk composition and the process of lactation in dairy cows, humans, and a wide diversity of other mammalian species. There are some big lessons revealed by the investigators' analysis.

**Rise of the Consortia**

Thomas Young, about 250 years ago, was said to be the last scientist who knew everything, from how the eye works to the wave-like properties of light that now underpin modern day quantum mechanics, the spooky physics of the very, very small (2). He was also crucial for the deciphering of the Rosetta Stone—undoubtedly a man with incredible talents. His research on light gave the first inkling that nature is exceedingly complex and it contrasted sharply with the dominant scientific theme of his day, the well-ordered planetary motions predicted by mathematics. The massive expansion of scientific knowledge since that time, especially in biology, means that any one person no longer has the breadth of knowledge and expertise, or the finances to master the scientific challenges of understanding and exploiting the complexities of nature.

In response, a strange thing recently happened—scientists started to coalesce (3, 4). They said it couldn’t happen, it was against the laws of nature. At first, scientists were found in their natural habitat in small gatherings surrounding free food after a campus function, and then in small crowds occasionally tolerating a
wayward soul from a long-lost scientific discipline, like statistics, or someone from industry who frequently asked the disquieting question “what does that mean?” Finally, they gathered in greater numbers with considerable international scientific and industry diversity, a herd moving in unison with a single obsessive purpose in mind. The consortium had arrived!

Leading the charge of the modern-day consortia are the geneticists and particle physicists (1, 3); one is focused on perhaps the greatest mystery of life, inheritance of form and function in large populations and their evolution through the eons, and the other on the strangeness and unpredictability of very small subatomic particles.

The word “consortium” seems modern, but it is derived from the Latin con meaning together and sors meaning fate i.e., a partnership of common fate. The Romans probably used consors to describe trade alliances and perhaps the occasional marriage. Kwok and colleagues (1) explain that the emergence of scientific consortia in the life sciences in modern times first began as a trickle in the 1970s, and became a flood of over 5,000 in 2016. The investigators noted that it is no coincidence that the number of life science consortia took off in the 2000s, a decade marked at its outset by the completion of the Human Genome Project and the realization of its enormous impacts (5, 6). Soon after, a cow genome sequence became available, which was exploited by an international consortium of scientists to better understand milk composition and lactation (7-9).

What are the drivers of scientific collaborations, especially within a consortium? Overwhelmingly for the individual, it is the excitement and sense of achievement in tackling a large and complex problem using innovative ideas. Kwok and colleagues also listed access to multidisciplinary expertise, improved access to resources and funding, increased scientific productivity, and accelerated careers (1). Perhaps the most important aspect of collaboration is that the achievements of the whole greatly exceed the sum of the individual contributions. Most consortia are set up with large-scale research funding for a fixed timeframe to address a highly specific goal, like the sequencing of the human genome. But there is another model for a consortium.

The Birth of the International Milk Genomics Consortium

Within the life sciences, agricultural researchers have been slow to form consortia. Kwok and colleagues write that agricultural scientists in 2016 were involved in about 10-fold fewer consortia than researchers involved in human-related investigations (1). They also suggested that the number of agricultural consortia at this time was actually a substantial overestimate due to several measurement issues. The reasons for this slow response of the agricultural research community are unclear, especially as food production underpins human health. Perhaps the species-centric employment of agricultural scientists, driven by industry interests, also limits their wider collaboration.

Kwok and colleagues (1) noted that with a similar backdrop in 2004 of poor large-scale scientific collaboration, members of the dairy industry and dairy organizations around the world sponsored the formation of the International Milk Genomics Consortium (IMGC) managed by the California Dairy Research Foundation. Unlike most consortia, the IMGC did not focus on a single narrow research or industry issue in a fixed time-frame. Rather, it set up an ongoing “collaborative, interactive and pre-competitive platform for the (dairy) scientific community and industry to accelerate the understanding of the biological processes...and facilitate transition of that knowledge into usable commercial benefits for (the dairy) industry.” The IMGC promoted these aims in an annual conference of scientists and industry representatives interested in lactation, milk composition, milk processing, and human health.
Kwok and colleagues highlighted important differences between the IMGC and most consortia (1). In particular, the IMGC did not fund research. The investigators suggested that this aspect was particularly important in their analysis of collaborations and scientific productivity within the IMGC, as the availability of research funding is known to skew such analyses (1). The investigators then put an analytical spotlight on the considerable success of the IMGC (1).

Top Marks for the International Milk Genomics Consortium

Kwok and colleagues assessed the impacts of the IMGC annual meeting on scientific collaboration, productivity, and quality. Their analytical approach used twelve years of data about authorship on milk-related research articles published in international peer-reviewed journals. Scientists universally point out that the publication of scientific articles is not for the faint-hearted. It is a tough and rigorous process where only the fittest articles survive. Publications are important as industry innovation often goes hand-in-hand with scientific innovation revealed in publications. The investigators then subjected the data to a searching statistical analysis (1).

The investigators first presented a startling visual representation of the increasingly complex collaborative networks formed between 2004 and 2016 for people who attended the annual IMGC meeting. A picture is worth a thousand words. The diagram showed that scientists initially worked in small disconnected groups that quickly merged into increasingly larger and more complex networks with time, which in turn eventually became a single large network. Kwok and colleagues reported an impressive increase of about 10-fold in the average number of co-publications per IMGC meeting attendee, a measure of scientific collaboration during the period from 2004 to 2016. They then compared the number of milk-related publications for all meeting attendees with randomly selected individuals who never attended an IMGC meeting, but who were involved in lactation research. The comparison demonstrated that scientists attending the IMGC meeting published about twice as many research papers compared with non-attendees. In a similar way, the investigators identified a massive increase in IMGC member co-authorships, a measure of collaboration, for attendees compared with non-attendees. Some publications are simply more important than others. While scientific impact can be difficult to assess, the citations of a publication by the author’s often hypercritical and highly competitive peers are recognized by scientists as a robust measure of research impact. Kwok and colleagues then compared citations for publications from IMGC meeting attendees with those from randomly selected non-attendees specializing in lactation research. The analysis demonstrated that citation rates were significantly higher for the attendees compared with non-attendees, implying higher scientific impact of publications from IMGC meeting attendees.

Implications

Kwok and colleagues concluded that there is a simple and important message from their analyses. The IMGC markedly increased scientific collaboration, productivity, and impact of researchers interested in the many intriguing properties of milk and the process of lactation. The investigators inferred that the success of the IMGC may be in spite of the lack of specific scientific focus, except for the lactation theme, and the lack of direct research funding. Simply stated, collaboration works.


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What’s in the Dairy Case? Potential Health Risks of Emulsifiers from Plant-Based Milks

- Emulsifiers are food additives that make foods more uniform in consistency and texture and help increase a food’s shelf life.
- Emulsifiers are found in plant-based milks like almond, soy, and rice milk.
- Recent research on mice and models of human gut cells suggests that emulsifying agents, such as carrageenan, alter gut microbiota and induce low-grade inflammation.
- The FDA considers carrageenan and other emulsifiers safe for human consumption, but the established links with inflammation suggest concerned consumers should choose unprocessed foods like cow’s milk.

Thousands of years ago, soymilk was nothing more than bean-flavored water, and if a food couldn’t be pickled, cured, fermented, or dried, it could not be preserved. Thanks to emulsifiers—natural and synthetic substances used to improve food texture, make foods more uniform in consistency, or increase a food’s shelf life—modern-day humans can enjoy soymilk with a creamy consistency and baked goods that stay fresh for months in the pantry. But do these improvements come at a cost? Although emulsifiers such as carrageenan have been classified as “generally regarded as safe” (GRAS) by the FDA, a growing body of evidence [1-10] suggests they may be partly responsible for increasing the incidence of inflammatory bowel diseases and the metabolic syndrome over the last 50 years. Although it may come as no surprise that processed foods are not good for overall health, many foods that consumers select because they are believed to be healthy, including some plant-based milk substitutes, contain ingredients that could potentially be making us sick.

Oil and Water

It is common knowledge that oil and water don’t mix. Oils are hydrophobic, or water fearing; the water molecules repel the oil molecules. But oil can be made a little less fearful of water by the addition of an emulsifier, which coats the oil molecules and makes them less likely to spread out and separate from the water molecules. Emulsifiers accomplish this chemical magic because of their unique composition—one part loves to be in water and one part loves to be in oil (aka amphiphilic) [11].

The addition of emulsifiers to oil and vinegar produces a salad dressing that does not require constant shaking and does not separate once it has been poured on the lettuce, and helps fat disperse more uniformly through bread and baked goods making it easier for them hold a consistent shape without gaping holes. Emulsifiers also influence the texture and “mouth feel” of foods because they keep the liquids evenly mixed. This is perhaps best illustrated by the transformation of beans, rice, and nuts into milk-like beverages, which use emulsifiers to increase the viscosity of the liquid to mimic milk’s creamy texture.
Milk does not require the addition of an emulsifying agent to maintain its creamy texture. Nature solved the problem of delivering hydrophobic fat droplets in water (after all, milk is mostly water) through an evolutionarily novel fat packaging system called the milk fat globule membrane (MFGM) \[12, 13\]. Specifically, milk fats, such as triglycerides, are surrounded by several layers of amphiphilic molecules (like phospholipids) that keep the fat molecules from clumping together \[12, 13\].

Many other well-known foods also have emulsifying properties. Eggs, soybeans, and sunflower seeds all contain the fat lecithin, which (like milk fat) is composed of amphiphilic phospholipids. A quick search of ingredient labels from foods in your pantry is sure to turn up several that list some type of lecithin.

But many of the most commonly used emulsifiers come from less familiar food sources. Carrageenan is a polysaccharide found only in the cell walls of red seaweed. Because of its unique chemical bonds, it has been used to replace fat in low-fat food products, thicken up foods such as plant-based milks and canned whipped cream, and even improve the texture of infant formula \[6, 8, 11\]. But what do carrageenan’s unique chemical bonds do once they are consumed?

**A Gut Reaction**

It is well understood how emulsifiers transform food products for human consumption, but what these emulsifiers do to the human gastrointestinal (GI) tract is less clear-cut. Researchers have long known that degraded carrageenan (as opposed to food-grade carrageenan used in human foods) could be used to induce gut inflammation in animal models and human cell cultures \[6, 7\]. Could similar substances in the human diet explain (at least in part) the rise in inflammatory bowel disease and the metabolic syndrome (which is linked to low-grade inflammation in the gut) over the last 50 years \[2\]?

Understanding how emulsifying agents could produce inflammation, and the sequelae of health issues that follow, requires a brief overview of the anatomy of the GI tract. Although it might not be the most appetizing analogy, picture the intestines as if they were a pizza—the epithelium is the bottom layer, or the dough, separating the contents of the GI tract from the bloodstream; on top of that is the mucus layer, the sauce; gut bacteria (or microbiome) are sprinkled on top of the mucus layer like cheese and toppings on the pizza sauce.

Keeping the microbiota on the top of this metaphorical pizza is critical to maintaining health. The outermost mucus layer is responsible for keeping the microbiota from moving into the lower mucus layer and subsequently to the epithelial cells that line the intestine. But as an extra line of defense, the membranes of the epithelial cells are stuck together by special proteins (appropriately called tight junctions) that form a nearly impenetrable barrier.

Initially, researchers thought that emulsifiers might act directly on the mucosal layer, decreasing its thickness and limiting its protective effect. However, a number of studies on mice and human intestinal cell lines grown in labs \[1-3, 5, 7, 10\] suggest that exposure to carrageenan and other synthetic emulsifiers promotes gut inflammation by disrupting the normal interactions between the microbiota and the mucosal layers. Instead of the gut bacteria staying on the topmost layer, the disruption causes them to move into the mucus layers, which then leads to an increase in the expression of inflammatory molecules and pro-inflammatory immune cells \[1, 3, 5, 7, 10\]. Moreover, a breakdown in the mucosal barrier affects the tight junction proteins holding epithelial cells together. With space in between the cells, bacteria can now move from the GI tract to the bloodstream, stimulating the production of even more pro-inflammatory immune cells \[10\].
With all of these inflammatory molecules released into the gut, it is not surprising that, in animal models, carrageenan exposure was associated with GI changes similar to those seen in human patients with inflammatory bowel diseases, including ulcerative colitis [7, 10]. But in addition to the direct effects on the gut, emulsifier-induced low-grade inflammation was associated with changes in glucose metabolism (hinting at the development of diabetes) and food intake (in some cases twice as much food consumed as by control mice, which may be linked to obesity)[1-5, 7].

The Safety Dance

If emulsifiers like carrageenan have induced inflammatory reactions in mice and human cell models, why are they still being used in human food manufacturing? Some food producers are responding to the growing scientific evidence and making changes. For example, many plant-based milks will advertise “carrageenan-free” on their cartons, choosing to use soy or sunflower lecithin instead. But the changes are voluntary, as the FDA has yet to change their designation of carrageenan (and other potentially harmful emulsifiers like carboxymethyl cellulose and polysorbate 80) as GRAS. The criteria for this designation are that the food additive is not toxic or carcinogenic [1-5], with no regard for the potential for the emulsifiers to cause inflammation. Many of those involved in researching the links between emulsifiers and inflammatory reactions believe the FDA criteria for what is “safe” in foods needs to be updated to reflect the myriad ways in which food additives can impact human health [3, 4, 11].

Of course, no one is claiming that emulsifying agents are the sole cause of low-grade inflammation that is associated with the metabolic syndrome. Food intake, glucose metabolism, and gut barrier function are the result of a complex interplay between genetics and environmental factors. Low intakes of dietary fiber, high sugar, and high saturated fat (traits common to processed foods) are also implicated in altering the composition and normal function of the gut microbiome, but their effects may be amplified by the presence of emulsifiers [3, 4].

It is not possible to do away with emulsifiers—although eating only fresh, additive-free food would be the ideal, this is not feasible for much of the world’s population. Without change from above, consumers with concerns about the link between emulsifiers and inflammation need to be more aware of what is in their food, even if that food is considered “healthy.” Many shoppers may not be aware that plant-based milk alternatives contain emulsifiers of dubious safety. If you are looking for a natural emulsion that can actually improve your health, look no further than the carton of cow’s milk in your refrigerator.

Biochemical Evidence that Breastfeeding Reduces the Odds of Diabetes

- Various studies that rely on self-reporting of diabetes have found that the longer women breastfeed, the less likely they are to develop type 2 diabetes.
- A new study that uses repeated biochemical sampling over a 30-year period has reached the same conclusion.
- The new study reports that breastfeeding is particularly effective at reducing the probability of developing diabetes later in life among women who have had gestational diabetes.

What percentage of people with diabetes have yet to be diagnosed? In one advanced democracy with a good public health system—the United Kingdom—the figure is thought to be about 20% [1]. Common sense suggests that in countries where healthcare is not free at the point of use, this percentage is probably higher. Because so many people who have diabetes do not know it, studies of diabetes that rely on self-reported cases always come with a sliver of doubt. This is why some newly published research by Erica P. Gunderson of Kaiser Permanente, and her colleagues, is important. It is the first long-term study—using biochemical diagnosis—to show that breastfeeding reduces the odds of a woman developing diabetes.

The new research is published in JAMA Internal Medicine [2]. It followed its 1238 female participants for a full 30 years, which was a much more thorough attempt to understand lifetime diabetes risk than previous studies that considered the role of breastfeeding duration. The researchers also had lots of different kinds of information to tease apart causal relationships. They knew, for example, about the participants’ weight over time, and other demographic risk factors, and whether the women developed gestational diabetes during each of their pregnancies.

Crucially, right at the start of the study period, in 1985, the participants had their fasting blood glucose measured. This was again measured six more times over the subsequent 30 years—alongside, in later years, other biochemical measures of diabetes, such as oral glucose tolerance and glycated hemoglobin.

Fasting blood glucose levels indicate how much sugar the body leaves hanging around in the blood instead of taking up into cells—which, in the case of type 2 diabetes, occurs because cells no longer respond to the presence of insulin. This measure is taken after a night’s sleep that is uninterrupted by midnight feasts, and (like the oral glucose tolerance test) indicates how the body handles glucose in the relatively short run. In this 30-year study, it was complimented with a glycated haemoglobin measure because the latter indicates average blood sugar levels during the past two to three months. All of the diabetes measurement methods give graded results. That is, they could diagnose prediabetes, as well as varying severity of the full disease. For this reason, the researchers not only had a completely accurate record of the study participants who developed diabetes, but they could look for trends in disease development.
The main result of the study is simple: the longer a woman breastfeeds, the lower the probability of her developing diabetes later in life. The exact odds, however, depend on various additional factors. Breastfeeding was found to be especially important for women who develop gestational diabetes. Among women in the study who at some point had gestational diabetes, those who did not breastfeed at all were 2.08% more likely each year to develop type 2 diabetes than those who breastfed for at least a year of their lives. Over time this additional yearly risk really adds up: 15 years down the line, breastfeeding for at least three months (compared with not breastfeeding) among women who had gestational diabetes came with a 45% lower incidence of diabetes. The overall effect was also statistically significant for women who at no point in any of their pregnancies developed gestational diabetes, although it was weaker. Among these women, never breastfeeding was associated with a 0.48% per year increased risk of developing diabetes.

This research is certainly not alone in indicating a protective effect of lactation in humans. The findings corroborate several studies that have relied on self-reporting of diabetes status. For example, a prospective study of more than 62,000 mothers in Shanghai, China, found a reduced incidence of diabetes over a five-year period among mothers who had breastfed relative to those who had not [3].

In addition, a couple of much shorter studies have measured fasting glucose and lactation duration. One, known as the Tehran Lipid and Glucose Study, was interested not merely in diabetes risk but also in the risks associated with women developing other indications of metabolic syndrome [4]. It found significantly reduced odds of developing diabetes among women who breastfed for at least seven months. Gunderson’s previous work in this area included a study known as SWIFT (Study of Women, Infant Feeding and Type 2 Diabetes after GDM Pregnancy), which enrolled women between August 2008 and December 2011, and then followed the women for just two years [5]. Despite the short follow-up period, it too found a link between the duration of lactation and diabetes development.

The latest research provides a weighty addition to existing evidence. Using biochemical analysis of diabetes status, as well as following women over three decades as opposed to just a few years, the new paper fills in both of these main weaknesses of previous research in the field. That breastfeeding duration predicts the risk of diabetes is an important public health message, which—as Splash! has previously argued—could encourage women to breastfeed. The evidence shows that this would not only improve their health but that of their infants, too.

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The Magic of Milk in the Morning

- Milk’s casein and whey proteins have beneficial effects on blood glucose levels and can also influence daily food intake by increasing satiety.
- A new study found that consuming both regular and high-protein cow milk with a carbohydrate-laden breakfast cereal slowed the digestion of carbohydrates and kept blood sugars low after breakfast and lunch.
- Adding milk to the breakfast menu may offer health benefits for type 2 diabetics as well as individuals looking to keep blood sugar levels in check and reduce overall food intake.

Odds are, your mother told you “breakfast is the most important meal of the day.” And, as is usually the case, your mother was right. Scientific studies continually support this folk wisdom—people that eat breakfast weigh less [1, 2], are less likely to gain lost weight back [2, 3], and have more stable blood sugar levels throughout the day [4, 5] compared with those who skip the first meal of the day. Not all breakfast foods offer these health benefits, however. Sorry bagels and donuts, but studies consistently show that protein-packed breakfast foods may make the biggest impact when it comes to jump-starting your metabolism and limiting spikes in blood sugar and overall daily food intake [6]. But a new study [5] shows that you may be able to have your breakfast carbohydrates and eat them too—as long as you eat them with milk.

Milk and other dairy products provide two unique classes of proteins, whey and casein. Whey proteins, which contain all nine essential amino acids, are known to have insulin-stimulating effects [7]. Insulin is a protein produced by the pancreas tasked with moving glucose from the bloodstream into cells throughout the body that use that glucose for energy. If cells already have enough glucose, insulin helps the body convert glucose into its storable form, glycogen. Thus, although milk contains carbohydrates (mostly in the form of the sugar lactose), it has a low glycemic index because the insulin stimulating effects of whey protein’s amino acids help keep blood sugar levels relatively stable after milk is consumed [7, 8]. Moreover, the boost in pancreatic insulin production from whey protein can also lower the glucose response to other foods consumed at the same time as milk [7].

But don’t forget about casein proteins. Although they do not directly stimulate insulin production, they play an important role in carbohydrate digestion and metabolism [5]. Whey proteins are digested quickly and are believed to send signals of satiety (that is “you are full, you can stop eating”) soon after consumption. Casein proteins, in contrast, are digested slowly and send out signals of satiety later than whey proteins. Studies have demonstrated that casein proteins stimulate the production of gastric hormones that also slow down the digestion of other foods [5]. And when it comes to avoiding spikes in blood sugar, slower carbohydrate digestion is better.

In a new study, Kung et al. [5] investigated these synergistic effects of whey and casein protein on glucose metabolism and food intake. Specifically, they were interested in how milk consumption alongside carbohydrates in the form of cereal at breakfast influenced blood glucose levels and satiety after breakfast, before lunch, and after lunch.

To tease out the effects of whey, casein, and total milk protein, they had their 32 healthy, young adult participants rotate (in random order) among 5 different study treatments (one treatment day per week): water with whey permeate (as the control); cow milk with normal protein content (3.1 %) and normal casein to whey ratio (80:20); cow milk with normal protein content (3.1 %) and modified casein to whey ratio (40:60); cow milk with high protein content (9.3 %) and normal casein to whey ratio (80:20); and cow milk with high protein content and modified casein to whey ratio (40:60).
Participants consumed 250 ml of each “milk” group with two servings of Honey Nut Cheerios (a high glycemic index oat-based cereal) after a 12-hour overnight fast. Blood glucose (via finger prick) and appetite (self-reported from a questionnaire) were measured immediately before and after cereal consumption and assessed again every 15 minutes for the next 200 minutes. In what may be the coolest study protocol ever, participants were provided cheese pizza and given 20 minutes to eat however many pre-weighed slices they desired 2 hours after cereal consumption. At the end, study researchers had 12 blood glucose measurements and 12 appetite responses for each participant at each treatment (and study participants had sore fingers and full stomachs).

Kung et al. [5] hypothesized that, compared with the control and normal milk treatments, milk treatments with higher whey content (60% as opposed to 20% whey) and milk treatments with higher protein content (9.3% compared with 3.1%) would be associated with lower blood glucose measurements before and after the pizza lunch, higher scores of fullness on the appetite questionnaire, and reduced food intake (fewer slices of pizza) during lunch.

Consistent with their prediction, treatments with higher protein content were associated with the lowest blood glucose levels both before and after lunch [5]. However, the high-protein treatments had no effect on how full participants were immediately before lunch or on their energy intake (i.e., total slices of pizza) during lunch. Also contrary to predictions, both normal and high-protein treatments with modified casein-to-whey ratios (40:60) had only a modest effect on pre-lunch blood glucose measurements [5] and there was no significant difference in the blood glucose response curves (a measure of glycemic index) between the normal (80:20) and modified (40:60) protein ratio treatments [5].

The treatment with the highest whey protein (high protein, 40:60 casein-to-whey ratio) was associated with the smallest changes in blood glucose levels relative to baseline (or, to put another way, had the lowest glycemic index), supporting the role of whey protein in stimulating pancreatic production of insulin. However, the significant reduction in blood glucose associated with a normal milk protein ratio suggests that the delayed digestion of casein proteins (and the associated delay in gastric emptying of carbohydrates) may beneficially influence blood glucose levels independent of insulin production [5].

The fact that all treatments made participants equally full is attributed to the high-energy content of the cereal plus the treatment milk (estimated to be around 500 kcal) and the short amount of time that elapsed between breakfast and lunch (120 minutes). Thus, the study authors concluded something college students have always known: when you are full from Honey Nut Cheerios, you just don’t eat as much pizza.

All joking aside, the study results are welcome news for the more than 100 million Americans living with type 2 diabetes. Weight loss through diet and exercise may be the long-term strategy to improve insulin sensitivity, but dietary recommendations that are easy to implement, like adding milk to the breakfast menu, can have immediate health benefits for individuals looking to control their blood glucose levels.


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