THE FOOD MATRIX

FOOD IS MORE THAN THE SUM OF ITS NUTRIENTS

by Dr Stephan Peters, Manager Nutrition Research, NZO (Dutch Dairy Association) Den Haag, the Netherlands

A resource about dairy-based nutrition
A product of the Consumer Education Project of Milk SA
www.rediscoverdairy.co.za

A publication for health professionals

THE CONSUMER EDUCATION PROJECT OF MILK SA TASKED DR STEPHAN PETERS TO WRITE AN ARTICLE ON THE DAIRY MATRIX. DR PETERS IS A RENOWNED RESEARCHER FROM THE NETHERLANDS AND IS CURRENTLY THE MANAGER ON NUTRITION RESEARCH AND FOOD LEGISLATION OF THE DUTCH DAIRY ASSOCIATION AND THE CHIEF EDITOR OF THE DUTCH NUTRITION MAGAZINE. HE IS RECOGNISED AS INFLUENTIAL IN TAKING NUTRITION SCIENCE FORWARD AND THE DEVELOPMENT OF FOOD–BASED DIETARY GUIDELINES.

NUTRIENT SCIENCE

Science is something that is continuously developing and discovering new things. This also goes for nutrition science. Until the second half of the past century nutrition science was mainly focused on nutrients. In the 17th century, for example, it was discovered that eating citrus fruit could prevent scurvy. Now we know that scurvy is a vitamin C deficiency. Later discoveries showed the relationship between vitamin B12 deficiency and beriberi and vitamin K's role in blood coagulation. Saturated fatty acids are known to increase LDL cholesterol, which is associated with a higher risk for cardiovascular disease. These are only a few examples of scientific discoveries based on nutrients. Therefore, the role of micro- and macronutrients in health is the basis of most food-based dietary guidelines in the world.[1]

FOOD SCIENCE

In the past decade, nutrition science has been changing its focus from nutrients to whole foods, for two reasons. The first is that, when compared to the first half of the 20th century, the incidence of nutrient and caloric deficiencies have been replaced by overnutrition and the concomitant increase of people who are overweight in many countries. This, in turn, has led to an increase in obesity and associated non-communicable diseases like Type 2 diabetes, cardiovascular disease, and cancer. The second reason is that epidemiological science has made a strong contribution to nutrition science by giving insight in the association between the intake of whole foods and non-communicable diseases.

This association gave new insight into the effect of food on health, which cannot be explained by the effects of (the sum of) individual nutrients. For example, nuts, seeds, vegetables, and fruits are found to decrease the risk of cardiovascular disease, and red and processed meat to increase the risk of colorectal cancer. There is scientific consensus about these associations, but they cannot be explained entirely by nutrients. One could say that thanks to the additional insights from epidemiology, nutrition science is changing into (whole) food science.

NUTRIENTS VERSUS WHOLE FOODS

One would expect nutrition or food science to have become more complete because of these findings. One plus one equals two, or in synergy, maybe three. Unfortunately, it is not so in this case. Very often, the health effects of whole foods are in contradiction to what can be expected based on their nutrient content. This is especially so in the case of dairy products. Although dairy products contain saturated fatty acids (and salt in the case of cheese), the increased intake of dairy products is associated with an increased risk of high blood pressure (because of the salt) and cardiovascular disease (because of the positive effects of saturated fatty acids on LDL cholesterol). However, this is not observed in high-quality epidemiological studies. On the contrary, the intake of dairy products is not linked to cardiovascular disease, and is sometimes shown even to decrease the effect on cardiovascular disease. How can these contradictory effects be explained? One explanation can be found in the flaws that come with epidemiological studies.

EPIDEMIOLOGICAL FLAWS

In nutritional sciences, epidemiology tries to find associations between the intake of nutrients and foods on health outcomes among populations or population groups. However, associations found with epidemiological studies do not automatically imply causal relationships. In other words, there is a chance that a discovered association between a food and its health effect is confused with another factor. These so-called 'confounders' are factors that disturb or even reverse a suspected causal relationship. Think about the association between the intake of fruit and vegetables and a decreased risk of cardiovascular disease. This can be a causal relationship, but it can also be confounded by

the fact that people eating more fruit and vegetables are the same people with an active and healthy lifestyle. These confounders can lead to mistakenly interpreting a found association as a causal effect. Fortunately, there are techniques in epidemiological studies for ruling out confounders. In addition, when several epidemiological studies find the same association, this decreases the risk of confounders. These studies can be pooled in a meta-analysis. The more studies a meta-analysis includes, the smaller the probability of a confounder. Ideally, intervention (clinical) studies can be used to find or confirm a causal relationship between a food and a health effect. A good intervention trial works by comparing an intervention to a placebo. This is the reason why there are not many good intervention trials available, because in nutrition it is impossible to have good placebos. It is not ethical to compare subjects for a period of time with and without vegetable or dairy intake. In conclusion, regarding the scientific evidence of health effects of whole foods, we have to rely mostly on high-quality data from epidemiological studies that exclude potential confounders as far as possible.

DAIRY HEALTH EFFECTS

This article focuses on the health effects of dairy products. Before proceeding to the next level of nutrition science, the food matrix, we will firstly sum up the most important health effects that are associated with the consumption of dairy products. The next four associations are based on scientific consensus, mostly based on epidemiological studies. This means that nutrition scientists are convinced that confounding factors can be ruled out.

1. The intake of total dairy, and especially yogurt, is associated with a decreased risk of Type 2 diabetes.[2,3]
2. The intake of total dairy is associated with a decreased risk of colorectal cancer.[4]
3. There is no association between the intake of dairy products and cardiovascular disease and stroke. In addition, the effects of full- and low-fat dairy products do not differ in any of the outcomes.[5] In some cases (no consensus yet), even a beneficial effect is found in these outcomes.[6]
4. Dairy plays a role in bone strength and health.[7]

The first two health effects of dairy products on Type 2 diabetes and colorectal cancer cannot be explained based only on the nutrients in dairy. The neutral or beneficial effects of dairy on cardiovascular disease are counterintuitive because dairy contains saturated fatty acids and salt in the case of cheese, both nutrients that are risk factors for cardiovascular disease. So, here the opposite is the case when compared to the first two points: the expected unhealthy effects of saturated fatty acids and salt are ruled out by high-quality evidence. The fourth effect can be explained to a large extent by the calcium provision of a dairy product. 'Total dairy' was found to have the most comprehensive health effects on non-communicable diseases. This means all dairy products combined; more specifically, dairy products including cheese, but excluding those with much added sugar. So, if most of these effects cannot be explained by the nutrients in dairy, and confounders seem to be ruled out, how can they be explained? The explanation can be found in a developing area of nutrition science: the food matrix.

With regard to its health effects, food is more than the sum of its nutrients. We do not eat individual nutrients, but we eat foods, and mostly in combination with other foods in a meal. All foods have unique physical and nutritionally complex structures that can influence the digestion of foods and the uptake of nutrients. This is called the food matrix, and in the case of dairy products, the dairy matrix. The food matrix concept might (in future) help to explain the 'surprising health effects' of whole foods.

SCIENCE OF THE FOOD MATRIX

Let's have a look at dairy products. From a nutrient perspective, dairy products are somewhat alike, but they also differ from one another regarding composition and structure. Thanks to the concept of the dairy matrix, we know more about why dairy does not seem to have a negative effect on cardiovascular disease. The fat in dairy, for example, cannot be considered without taking the biological fat membranes that enclose the fat drops into account. These so-called milk fat globule membranes (MFGM) have a significant effect on the digestion of dairy products and the uptake of dairy fat.[8] The MFGM seems to prevent the negative effects of saturated fatty acids on LDL cholesterol (see cheese matrix study below). Yogurt and cheese are examples of fermented dairy products with bacteria that produce bioactive peptides and short-chain fatty acids that can have a specific health effect. When looking at the structure, milk is a liquid, yogurt has a semi-liquid structure, whereas cheese has a solid structure. These different structures can have different effects on digestion or health when compared to individual nutrients. Look at the following two examples:

(I) Calcium supplement versus dairy calcium
Dairy is the most important source of calcium for most people. Therefore, dairy plays a role in bone health. There are additional health effects associated with calcium. As described above, dairy intake is associated with a decreased risk of colorectal cancer and Type 2 diabetes, and has a neutral effect on cardiovascular disease. Some of these effects can be explained by calcium. We know that calcium supplementation also protects against colorectal cancer. However, the intake of calcium supplements is associated with a higher risk of cardiovascular diseases, an effect not found with dairy.[5] Here we see a different effect of individual nutrients and whole foods like dairy products: a confirmation of the food matrix effect.

(ii) Cheese matrix study

A recent study showed the differential effects of the degree of the content of main cheese components on LDL cholesterol. Participants were divided into three groups. They took 42 grams of dairy fat per day for six weeks, with the same amount of calcium and protein, but in different compositions in the form of:

1.Cheddar cheese
2.Reduced-fat cheese plus equivalent butter
3.All fat in the form of butter, with additional calcium supplement and caseinate (equivalent protein) to mimic the macronutrient content of butter

After six weeks the LDL cholesterol in the cheddar cheese group was significantly lower than in the reduced-fat cheese group, which was lower than the butter group. So, this study showed that the effects of nutrients eaten in a whole food are significantly different from that of a mixture of the same nutrients. So, regarding the LDL cholesterol effects of cheese, this study shows that the 'whole' is more than the sum of its parts.

CONCLUSION

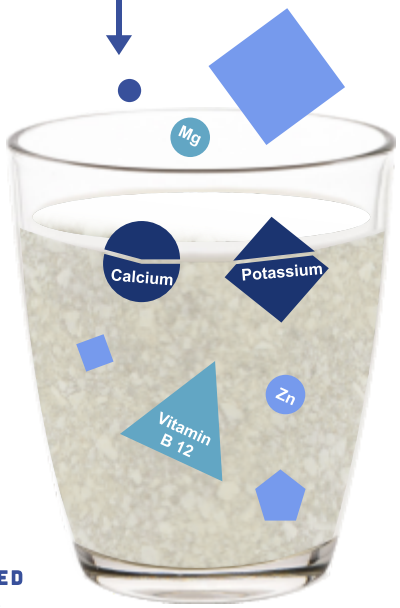
THERE SEEMS TO BE ENOUGH EVIDENCE FOR FOOD MATRIX OR DAIRY MATRIX EFFECTS. THIS CONCEPT CAN HELP NUTRITION SCIENCE MOVE FORWARD IN EXPLAINING SPECIFIC HEALTH EFFECTS THAT CANNOT BE EXPLAINED BY NUTRIENTS ALONE. NEVERTHELESS, NOT ALL DAIRY'S HEALTH EFFECTS CAN BE EXPLAINED THROUGH THE MECHANISM OF THE DAIRY MATRIX. ALTHOUGH THERE ARE MANY KNOWLEDGE GAPS IT IS DESIRABLE TO DO MORE RESEARCH ON THE FOOD OR DAIRY MATRIX.[9] HOWEVER, WE CAN CONCLUDE THAT DIETARY GUIDELINES MUST NOT ONLY FOCUS ON NUTRIENT EFFECTS BUT SHOULD ALSO TAKE INTO ACCOUNT THE HEALTH EFFECT OF FOODS AS A WHOLE.

THE WHOLE IS MORE THAN THE SUM OF THE PARTS

THE MATRIX EFFECT OF

DAIRY

DAIRY PRODUCTS ≠ FORTIFIED FOODS



REFERENCES

1. FAO (2021) Food-based dietary guidelines. http://www.fao.org/nutrition/education/food-dietary-guidelines/en/, (accessed 12 April 2021).
2. Alvarez-Bueno, C. et al. (2019) Effects of milk and dairy product consumption on Type 2 diabetes: Overview of systematic reviews and meta-analyses. Adv Nutr 10 (suppl_2), S154–S163.
3. Gijsbers, L. et al. (2016) Consumption of dairy foods and diabetes incidence: A dose-response meta-analysis of observational studies. Am J Clin Nutr 103 (4), 1111–24.
4. Vieira, A.R. et al. (2017) Foods and beverages and colorectal cancer risk: a systematic review and meta-analysis of cohort studies, an update of the evidence of the WCRF-AICR Continuous Update Project. Ann Oncol 28 (8), 1788–1802.
5. Kromhout, D., Spaaj, C.J.K., de Goede, J., Weggemans, R.M. (2015) The 2015 Dutch food-based dietary guidelines. Eur J Clin Nutr 70 (8), 869–878.
6. Dehghan, M. et al. (2018) Association of dairy intake with cardiovascular disease and mortality in 21 countries from five continents (PURE): a prospective cohort study. Lancet 392 (10161), 2288–2297.
7. Geiker, N.R.W. et al. (2020) Impact of whole dairy matrix on musculoskeletal health and aging current knowledge and research gaps. Osteoporos Int 31 (4), 601–615.
8. Rosqvist, F. et al. (2015) Potential role of milk fat globule membrane in modulating plasma lipoproteins, gene expression, and cholesterol metabolism in humans: a randomized study. Am J Clin Nutr 102 (1), 20–30.
9. Thorning, T.K. et al. (2017) Whole dairy matrix or single nutrients in assessment of health effects: current evidence and knowledge gaps. Am J Clin Nutr 105 (5), 1033–1045.