# MYTH OR SCIENCE?
# LOSING WEIGHT WITH LIGHT PRODUCTS

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**Critical Appraisal**

Nowadays, almost every product in the supermarket also has a light version or is even replaced by it. These products become more and more popular and, in the Netherlands, there is even a plan in which these products will get a subsidy [1]. The reason for this is the fact that overweight and obesity are becoming a serious health problem with a rising incidence each year [2]. Being overweight is a problem for about one-third of the European population, who in general have a calorie-dense diet and a relative lack of exercise [2]. This results in a net positive energy balance and increases the risk of getting overweight or obese [3]. The long-term-associated health outcomes include dyslipidaemia (an abnormal amount of lipids in the blood), coronary artery disease, type 2 diabetes mellitus, hepatic steatosis (fat accumulation in liver cells), cerebrovascular disease, and insulin resistance [3]. Stimulation of using light products might contribute to losing weight [1]. However, some theories believe that light products are no better for your weight than the normal products and that they might even be unhealthy or harmful. Are these theories myth or science?

## Introduction

About 86% of the Americans use light products, according to a survey from the Calorie Control Council, but what is the difference compared to the normal product [4]? The definition of a light product is determined by law; it contains at least 30% less energy (kcal), fat or sugars compared to the regular product [5]. A product that contains at least 30% less fat, contains, in general, more sugar than the normal product [6]. Therefore, it contains the same number of calories or even more [6]. In a product that contains more than 30% less sugar, these sugars are in general replaced by low energy sweeteners (LES) [4]. These are synthetic or natural chemical compounds that stimulate the sweet taste receptors on the tongue [4]. LES contain (almost) no calories and are hundreds to thousands times sweeter than normal sugar [4]. In Europe, there are nine approved LES and those all have an E-number, which means that they have been checked by the European Food Safety Authority and are considered to be safe [7]. One of the most commonly known and used LES is aspartame, also known as E951 [7]. It is added to over 6,000 products like light drinks, chewing gum, yoghurt and toothpaste [7].

### Light products and weight loss

In the hope of losing weight, many people that are overweight choose to consume light products containing LES instead of products containing sugar. In theory, this would be a good choice. There is no doubt about the fact that LES reduce the energy density of foods and beverages [8]. Therefore, this can contribute to a reduced energy intake and caloric deficit over the day with subsequent weight loss in the long-term [8]. However, some theories suggest that the consumption of LES would contribute to overeating and/or increased energy intake and therefore weight gain.

First, consuming light products would reflect a type of cognitive process in which a light product is perceived to be 'healthy' and that this grants permission to overconsume this product or other 'non-healthy' foods [8-11]. However, the consumption of beverages sweetened with LES has no effect on total daily energy intake [12]. Also, LES consumption is not significantly related to later energy intake [9,13-16]. It does not matter whether the participants were blinded for the intervention or not [9]. Another mechanism that would increase energy intake is the relationship between the caloric density of food and sweet taste changing due to LES consumption [9,17-20]. For people consuming LES, the validity of a sweet taste as a signal for caloric food would be weakened and the ability to evoke responses that maintain energy homeostasis would be degraded [8,9,18-20]. However, a large number of studies report only limited effects of various LES on glycaemic, insulinemic and gut hormone responses [9,12,21-23]. Also, studies comparing LES to unsweetened products, water or nothing suggest that the exposure to sweetness itself is not a significant stimulus for later energy intake [9,13-16].

Another theory, commonly spread via social media and food bloggers, is that LES would have an effect on the cephalic phase insulin response [24]. Consumption of LES would increase the insulin release due to the sweet taste [24]. Contradictory to the intake of glucose, there will be no increase in sugar in the blood which would result in a low blood glucose level [24]. Therefore, this would lead to overeating, increased energy intake and weight gain [24]. However, a recent randomised controlled trial, published in 2018, with a sample size three to nine times greater than previous similar trials, found no effect on the insulin concentration for daily aspartame consumption for 12 weeks [25]. Also, another randomised controlled trial found no effects in glucose and insulin response on the day of LES consumption [12]. In addition, multiple other studies showed no acute changes in the release of insulin after consuming LES [8,21,22,26,27]. Therefore, there is a lack of evidence to confirm the theory that LES would not increase the insulin release, neither direct after consumption, nor after long-term use.

In 2016, a systematic review of the evidence from human and animal studies on LES consumption and body weight was performed, including meta-analyses [9]. In total, 141 articles reporting 335 studies or comparisons were included; these were animal studies, observational (prospective cohort) studies, short-term intervention studies and sustained intervention studies [9]. The main conclusion of this systematic review is that the consumption of products containing LES instead of sugar leads to reduced energy intake and body weight, in children and adults [9,13-16,28-30]. Therefore, this systematic review supports the disempowerment of the aforementioned theories that LES consumption would contribute to overeating and/or an increased energy intake and therefore weight gain.

**Light products and health effects**

In light products, most discussion is about the safety of LES, especially about aspartame and its metabolites [4]. Aspartame has an acceptable daily intake (ADI) level of 40 mg/kg/day, which is equal to 2.5 litres cola light [4]. This level is determined using the "no observed adverse effect level" with daily exposure [4,31]. Intake below the ADI level is, therefore, considered to be safe. In most European countries the ADI level is not exceeded, even not in worst-case scenarios [32]. After the intake of aspartame, it is hydrolysed by esterases and peptidases in the gastrointestinal tract [31]. Aspartame is broken down into methanol and two amino acids: aspartic acid and phenylalanine [31].

An extreme excess of aspartic acid would cause hyperexcitability of neurons and lead to the degeneration of astrocytes and neurons since it is a precursor of the amino acid glutamate [31]. Very high concentrations of phenylalanine would contribute to reduced levels of dopamine, serotonin and noradrenaline in the brain [31,33]. This would be due to an extreme excess of phenylalanine that would block the neutral amino acid transporters (NAAT) [31]. These transporters are used to transport various amino acids over the blood brain barrier which are important for neurotransmitters' synthesis [31]. For adults, daily intake of aspartame is about 2-10 mg/kg/day and 50% of this is transformed into phenylalanine [34]. For a typical person weighing 75 kilograms and a consumption of 10 mg/kg/day, this would be 375 milligrams g of phenylalanine a day. However, normal daily intake from the diet of the essential amino acid phenylalanine from protein-rich products like milk, eggs and meat is about 2.5-3 grams [35]. Therefore, even when the ADI of 40 mg/kg/day is reached, only 1.5 grams of phenylalanine would be formed from aspartame against a normal daily intake of 2.5-3 grams (figure 1). In addition, phenylalanine is an essential amino acid and it is important in the structure and function of many proteins and enzymes [35]. A recent study even found an inverse association between a higher dietary intake of phenylalanine and obesity risk [35]. Only 40% of aspartame is transformed in the amino acid aspartic acid. Aspartame intake of the ADI for a typical person weighing 75 kilograms, would then lead to 1.2 grams against a normal daily consumption for adults from the diet of about 5 grams (figure 1) [35]. Normal aspartame consumption (below the ADI) will, therefore, never lead to aspartic acid and phenylalanine concentrations high enough to cause effects in the brain [32]. Only in people with the metabolic disease phenylketonuria, phenylalanine will lead to negative effects in the brain. This is because they are not able to break down phenylalanine, which will accumulate [36].

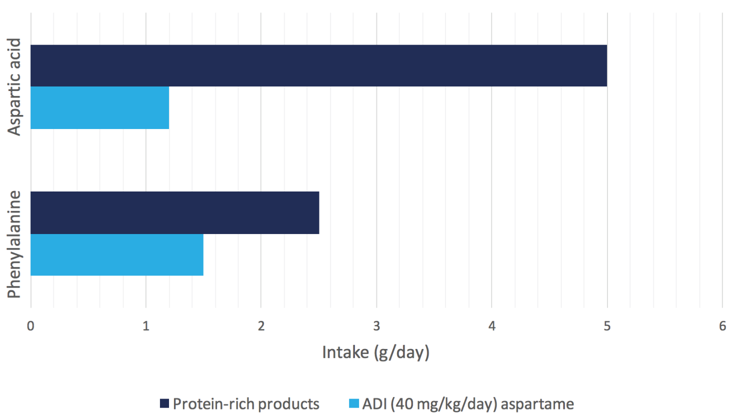


***Figure 1: Comparison of phenylalanine and aspartic acid intake from protein-rich products and aspartame consumption.***

*After aspartame consumption, it is transformed in phenylalanine (50%) and aspartic acid (40%). These amino acids would actually have effects in the brain. However, for a typical person, weighing 75 kilograms, an aspartame intake of the ADI (40 mg/kg/day) is equal to only 1.5 grams of phenylalanine per day. On the other hand, the normal daily intake of phenylalanine from protein-rich products is about 2.5-3 grams per day. An aspartame intake of the ADI is equal to 1.2 grams of aspartic acid per day. The normal daily intake of aspartic acid from protein-rich products, on the other hand, is about 5 grams per day. Therefore, phenylalanine and aspartic acid concentrations due to the consumption of aspartame will never reach concentrations high enough to cause effects in the brain. In addition, daily intake of aspartame almost never reaches the ADI; normal daily intake is only 2-10 mg/kg/day, resulting in even lower phenylalanine and aspartic acid concentrations because of aspartame consumption.*

Another commonly heard claim is that aspartame would be carcinogenic and genotoxic. There is some *in vitro* evidence for induction of chromosomal damage, however, this is probably not due to primary DNA damage but to a secondary effect of cytotoxicity [37]. DNA repair assays did not show any DNA-damaging properties for aspartame [38]. Also, some other studies found no *in vitro* and *in vivo* induction of gene mutations [37,39,40]. In general, there is limited evidence to suggest that consumption of aspartame may increase the risk of certain cancers [41]. For normal consumption of all LES, the possible risk to induce cancer seems to be negligible [38].

Diet can influence the gut microbiota profile and analysis in mice and humans suggest that LES would disrupt the balance and diversity of gut bacteria [42]. The gut bacteria have an important role because specific enzymes that are not encoded in the human genome are employed by the microorganisms in the gut [43]. These enzymes enable the host to extract calories from otherwise indigestible foods [43]. Altered microbiota, due to consumption of LES, would increase hepatic lipogenesis in adipocytes, thereby promoting storage of calories harvested from the diet into fat [44]. Moreover, this altered microbiota would also be correlated with disease markers linked to obesity; impaired glucose tolerance and elevated fasting blood-glucose levels [45]. However, the gut microbiota is very complex and there is no conclusive evidence on this topic [42]. This might be because of individual variability, interactions, unique chemical composition and metabolism of different LES and the dose that is consumed [42].

## Conclusions

Some theories suggest that inclusion of light products containing LES in the diet promotes energy intake. This would be due to several mechanisms caused by LES like a disbalance in energy homeostasis, overeating of other 'non-healthy' foods due to cognitive processes and an effect on the cephalic phase insulin response. Therefore, the addition of these products would also lead to an increase in body weight. However, several studies, including a recent very extensive systematic review, conclude the opposite; products containing LES contribute to a reduced energy intake and body weight.

The second finding of this article is that consumption of LES below the ADI is considered to be safe. For example, genotoxic and carcinogenic health effects of LES are in general negligible. Also, the theory that aspartame and its metabolites would have some health effects in the brain is invalidated. The metabolites aspartic acid and phenylalanine would lead to the degeneration of astrocytes and neurons, respectively and to decreased levels of serotonin, dopamine and noradrenaline in the brain. However, normal consumption of aspartame below the ADI will never reach to concentrations high enough to cause these effects. Even an intake higher than the ADI will lead to phenylalanine and aspartic acid concentrations much lower than the normal daily intake from protein-rich products. Last, there is no conclusive evidence that LES would change the composition of gut bacteria and the possible consequences of this. In conclusion, products containing LES contribute to a reduced energy intake and body weight and as long as there is no excessive use of these products there are no health consequences.

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