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Olestra: the Price of a Free Lunch

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Olestra, also known as sucrose polyester, is a heterogeneous synthetic fat substitute consisting primarily of hexa-, hepta-, and octaesters formed by the reaction of sucrose with fatty acids derived from edible oil sources, including soybean, corn, and cottonseed.(1) Olestra shares many of the physical properties of traditional dietary fats, including texture, palatability, and flavor-enhancement (2); however, it is different in that it contributes virtually no calories to a meal. How is this possible? Digestible triglycerides consist of three fatty acids joined by ester linkages to an alcohol known as glycerol. Esters of alcohols with more than three fatty acids become more and more difficult to digest and absorb. Six fatty acids joined in ester linkages to a central alcohol moiety are enough to render the molecule unsusceptible to hydrolytic cleavage by pancreatic lipases.(1,2) Since lipids (even typical triglycerides) cannot be absorbed across the intestinal mucosa without first being broken down, olestra moves through the intestine without being absorbed and exits the gastrointestinal (GI) tract intact. What is the difference between olestra and existing fat substitutes available to the food industry? Although fat-free foods have been around for some time, olestra is the first substitute that does not degrade when cooked.(2) Olestra potato chips, for example, will be fried rather than baked, thus offering the oozing, greasy, can't-eat-just-one appeal of the original minus the fat.

This sounds like a dream come true for an obese America and the doctors who cannot convince their patients to reduce their excessive fat intake levels even when the risks include coronary heart disease and cancer.(3) Olestra does, however, have its opponents, mainly in the health care and public health fields, and the fact that the U.S. Food and Drug Administration has pondered the approval of this food additive for about a quarter of a century might suggest that there was much to think about. This paper will focus on recent research investigating the potential negative side effects of olestra.

One of the first issues to consider, of course, is whether or not the product has the potential to harm the consumer. Procter & Gamble, the makers of olestra, have demonstrated in a two-year study on rats that "chronically" ingested olestra is both nontoxic and noncarcinogenic.(4) The statistically significant increases, in one group of olestra-fed rats, of the incidences of pituitary adenomas and mortality and the dose-dependent positive trend toward increased mononuclear cell leukemia in the same group were all dismissed as unrelated to olestra ingestion because these are "commonly observed" lesions in this particular animal.

P & G also looked at the possible accumulation of this compound, which is resistant to enzymatic degradation, in various body tissues.⁵ Intravenous injection studies suggested that the most likely place for olestra to accumulate, once in the bloodstream, was in the liver. This study looked at the livers, hearts, kidneys, spleens, lymph nodes, and adipose tissues of monkeys and rats fed olestra for about two years. The compound was found in the livers of only some of the animals and even there only in negligible amounts, leading the researchers to conclude that "such accumulation presents no health concerns." In another rat study (6), P & G confirmed the above findings about the accumulation of intact olestra in the liver, and also demonstrated that in a typical dose, less than 0.15% is absorbed, primarily as fructose and glucose from the breakdown of a small fraction (<0.5%) of penta- and lower sucrose esters. Thus, it is suggested that olestra is not digested or absorbed, nor does it accumulate in the body in significant amounts or produce toxic effects.

Another issue which is of great concern is olestra's effect on the absorption of lipophilic compounds, which normally enter the bloodstream by riding along on lipid micelles formed by broken down triglycerides. One might reasonably assume that a lipid-soluble compound that is consumed in high quantities and is neither digested nor absorbed would soak up such lipophilic nutrients and carry them out of the GI tract before they are properly absorbed. Plasma cholesterol concentration has already been shown to be reduced by olestra intake (3), and this, of course, is good news to those wishing to lower serum cholesterol levels. There are, however, also many more desirable compounds which suffer the same fate.

Vitamins D and K are two such compounds. In one study, P & G found that dietary vitamin D absorption was reduced by about 19% in volunteers ingesting olestra.(7) This is not considered to be of great concern since the majority of the vitamin D supply comes from endogenous sources, and even in situations (low sun exposure) where dietary vitamin might contribute as much as 50% of the total, consuming moderate to high levels of olestra is not expected to reduce levels of this vitamin to below the accepted standard of 25

nmol/L. It has also been shown that vitamin K levels are not significantly altered by olestra ingestion even in a subject population "on the borderline of vitamin K sufficiency."(8)

Another study considered the absorption of vitamin E and carotenoids, a class of naturally occurring fat-soluble compounds with antioxidant properties.(3) This time the plasma concentrations of vitamin E in subjects consuming olestra was reduced by 13%. Even more dramatic, however, was the drop in plasma concentrations of various carotenoids (between 18% and 52%) including 34% for (-)-carotene and 52% for lycopene. There was also a significant decrease in serum cholesterol (6%). Carotenoid levels have been associated with protection from a variety of conditions including cancer, coronary heart disease, and cataracts, and the levels observed in subjects consuming olestra in this study were low enough to place them at risk.

Finally, other groups have found significantly reduced absorption of drugs such as digitoxin (9), cyclosporin (10), and colchicine (11) with olestra intake. The suggestion here is that the actions of these and other lipid-soluble drugs (when administered orally) might be impaired by olestra intake such that dosages might have to be adjusted depending on the patient's level of olestra intake, assuming this level is constant and predictable for a given patient.

Other considerations that the FDA had to take into account during its deliberation on the olestra issue included claims that the consumption of this compound produced higher incidences of loose, soft, or oily stools, flatulence, and what is delicately referred to as "urgency of defecation." (12) While such effects are not critical health hazards, they are of some concern to the public, and they were addressed in a P & G funded study that measured the rate of transit of radiolabeled pellets through the GI tracts of healthy human volunteers. (1) Gastric emptying appeared to be unaffected by olestra intake, and although there were trends toward faster transit through the small intestine and colon in subjects taking olestra, the effects were not significant. Stool frequency was increased in the olestra group, but no subject in this group had a movement more than twice a day. Unfortunately, this was a 72-hour study, and thus it does not truly address the concerns of those wondering about chronic olestra intake.

P & G have even shown, in a 9-day study,(2) that substitution of dietary fat with olestra can produce a real (significant and dose-dependent) reduction in the percentage of daily energy from fat, while total energy intake is maintained by a delayed compensation response involving an increased carbohydrate intake. No evidence was found for an increase in fat intake as a specific compensatory mechanism in the olestra groups.

It is generally agreed that a reduction in body fat and/or fat intake would be beneficial for most. There are many ways to achieve this goal. Olestra can help in this effort without requiring the sacrifice of tempting, fatty foods. Is olestra directly harmful? The FDA says "no." Is the taste and feel of fatty foods worth the inconvenient GI symptoms and possible indirect risks associated with olestra? The FDA has left it up to the educated individual to decide this with their recent decision to approve the use of olestra in certain savory snack items carrying warning labels. This is good news for P & G. Is it good news for America? The experiments on olestra thus far have been fairly short-term (up to a few years) and many have used animals because it has been impossible to measure the effects of chronic high intakes of a compound in humans over a lifetime. The grand experiment is about to begin.

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