Conjugated Linoleic Acid (CLA)

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Abstract

CLA, also known as bovinic acid or rumenic acid, is a type of fatty acid. It is a mixture of positional and geometric isomers of linoleic acid that the rumen bacteria convert from linoleic acid. It is the only naturally occurring substance that has been proven to prevent cancer. It considered as a healthy fat that occurs naturally in many foods, particularly milk and meat from ruminants such as cows, sheep, and goats. It is a powerful cancer fighter along with numerous other health benefits such as prevents obesity, atherosclerosis, and type 2 diabetes.

Chemistry and Definition

Conjugated linoleic acid (CLA) is a group of polyunsaturated fatty acids that are positional and geometric isomers of linoleic acid (C18:2), molecular formula C18 H32 O2. It contains 18 carbon atoms and two double bonds holding the chain together, similar to Linoleic Acid (LA). The main distinction is in the placement of those bonds. Its precursor i.e trans vaccenic acid, are naturally produced during bacterial fermentation in the rumen of ruminant animals.

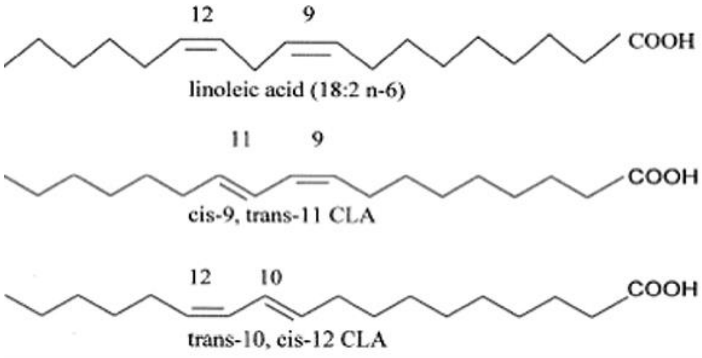

Fig 1: structure of linoleic acid, CLA (c-9, t -11) & (t-10, c-12)

Natural Conjugated Linoleic Acid Sources

Conjugated linoleic acid content is higher in grass-fed animals and their products than in animals fed grains or other types of fodder. CLA levels in grass-fed meats can range between 300 and 500 times higher. CLA levels in grass-fed milk products such as whole milk, cream, butter, cheese, and yogurt were extremely high. Fermented dairy products are incredibly high in CLA due to lactic acid bacteria, and fermentation increases the CLA content. Furthermore, beneficial bacteria found in the digestive tract can produce CLA, which aids in maintaining healthy gut flora. Dairy products are the richest source of CLA, accounting for roughly 70% of total dietary CLA, compared to 25% from beef and smaller amounts from other ruminants. Organic milk contains the most CLA. As a result, non-vegetarians, ova-vegetarians, and lacto-vegetarians can quickly meet their conjugated linoleic acid needs. Due to a restricted diet, vegans struggle to get their daily dose of CLA. It can be found in cooking oils such as sunflower and safflower. Cooking foods may raise CLA levels.

Meat from grass-fed cows, sheep, bison, goats, and other ruminant animals is also high in CLA. It is naturally produced in the digestive tracts of ruminants such as cattle, goats, sheep, buffalo, and, to a lesser extent, pigs, chickens, and turkeys, and the synthesis occurs via fermentative bacteria, Butyrivibrio fibrisolvens, which isomerize the linoleic acid in CLA, or via 9-desaturase of 11-trans octadecanoic acid. Beef fat has 9-cis and 11-trans isomers of CLA and contains between 1.7 and 10.8 mg of CLA per gram of fat. Organically raised grass-grazed breeds have additional advantages such as being hormone- and antibiotic-free, having lean protein, and having a lower fat content.

Artificial Conjugated Linoleic Acid Sources

Commercial supplements containing CLA are also available. Commercially, CLA can be produced by modifying the chemical structure of vegetable oils. During this artificial modification, the original structure of the CLA is completely compromised. Thus, the health benefits of CLA from natural foods cannot be met by the synthetic form of CLA.

Process Influence on Conjugated Linoleic Acid

During processing and storage, the lipids in milk and milk products undergo structural, chemical, and physical changes. Nutraceuticals such as CLA,

sphingomyelin, and butyric acid are found in milk lipids. Trans fats are formed in the lipids of cattle's rumen during biohydrogenation. However, they can also form during high-temperature cooking methods such as baking or frying. A study concluded that, with the exception of microwave heating, heat treatments and refrigerated storage of milk and dairy products, did not result in significant changes in the trans fatty acid isomer and CLA contents.

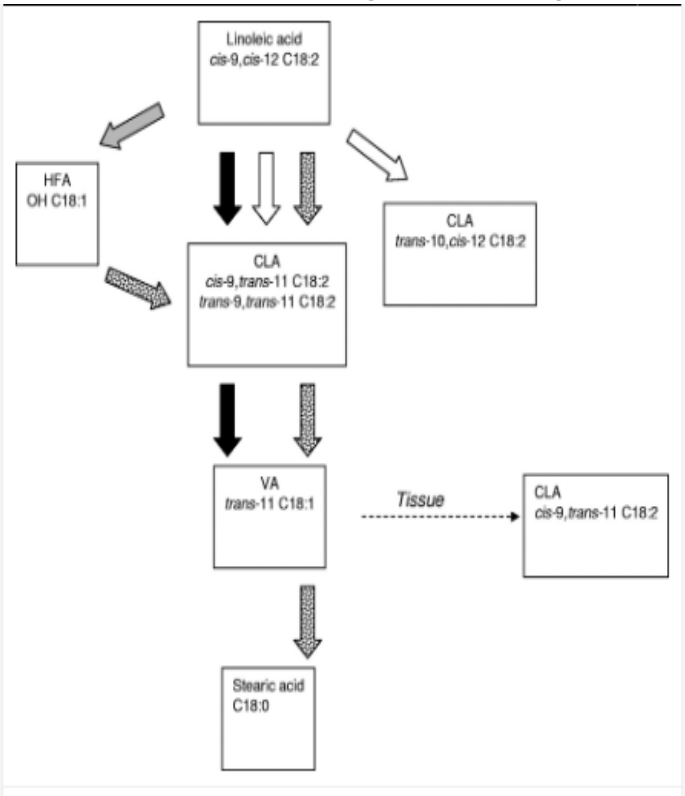

Fig. 2 Pathway Linoleic Acid metabolism by bacterial Species isolated from human gut

Conjugated Linoleic Acid Metabolism and Bioavailability

CLA is a trans-fatty acid, but it is a natural trans-fat found in various healthy foods and has health benefits. Much research indicates that industrially produced trans-fat has adverse health effects. Naturally occurring trans fats differ from the previous type and may benefit consumers' health. Linoleic acid (LA) (cis-9, cis-12-18:2) is metabolized in the human colon by conjugated linoleic acids (CLA) (primarily cis-9, trans-11-18:2) to vaccenic acid (VA) (trans-11-18:1) (both of which are beneficial to health) and then to stearic acid (18:0). A similar pathway occurs in the rumen, where this process, known as biohydrogenation, has significant implications for the fatty acid composition of meat and milk. The microbiology of biohydrogenation in the rumen has received a lot of attention, but similar research on the human intestinal microbiota has yet to be done.

Roseburia species were found to be among the most active in metabolizing linoleic acid (cis-9, cis-12-18:2) in a survey of 30 representative strains of human gram-positive intestinal bacteria. Various Roseburia spp. In human tissues and the intestine, these compounds are precursors of the health-promoting conjugated linoleic acid cis-9, trans-11-18:2. CLA is simply a rumen bacterial excretory metabolite or metabolic intermediate. It is typically produced in ruminants for symbiotic purposes, promoting the animals' health and longevity.

Animal studies and clinical trials have indicated that CLA may be useful in improving human health. The uptake of CLA formed in the intestine seems to be minor. However, local effects on gut tissue might be anticipated. It is now well established that CLA have antiproliferative and anti-inflammatory effects on colonocytes, so provision of CLA in the intestinal lumen could be considered beneficial, particularly for inflammatory bowel diseases, such as ulcerative colitis and Crohn's disease. Bacteria from other ecosystems and from food products which are also found in the human gut, including strains of *Lactobacillus*, *Propionibacterium*, and *Bifidobacterium*, have been known for some time to possess the ability to generate CLA.

Conjugated Linoleic Acid's Physiological Effects and Health Benefits

CLA is gaining popularity due to its purported weight-loss, anti-atherosclerotic, anti-diabetic, and hypotensive properties. Some studies have found that CLA supplementation improves insulin resistance and influences osteoarthritis pathogenesis by modulating inflammatory factors. CLA has been shown to have health benefits in the prevention and management of various conditions, including cardiovascular disease, cancer, and obesity, and it may change body composition by lowering body fat percentage.

Reduction in Body Fat Percent

The possible mechanism by which CLA can alter body composition involves metabolic changes

that favor the reduction of lipogenesis and the potentiation of lipolysis, accompanied by fatty acid oxidation in skeletal muscle, due to increased carnitine palmitoyl-transferase-1 activity and action, or possibly because of adipocyte differentiation inhibition. Therefore, researchers studied the effect of CLA supplementation on the lipid and hormone profiles, as well as the activity of the enzymes involved in the oxidation process. According to research, CLA isomers 10-trans and 12-cis, as opposed to 9-cis 11-trans, significantly increase lipolysis in human adipocytes while decreasing fatty acid synthesis. This would explain some of the possible CLA action mechanisms on body composition.

Even though the research was done in vitro, the metabolic hypotheses to explain CLA's body fat-lowering action began with the control of the expression of genes involved in the differentiation of pre-adipocytes into mature adipocytes; in other words, the expression of these genes would result in reduced lipogenesis. CLA appears to interact with the PPAR Co-activator complex, increasing gene transcription related to adipocyte differentiation, lipolysis (-oxidation), mitochondrial biogenesis, and insulin sensitivity, all associated with weight loss.

CLA's fat-lowering properties were discovered in rodents first, and the debate over whether they can be extrapolated to humans continues. Several mechanisms of action have been proposed, including decreased energy intake, increased energy expenditure, reduced adipocyte size, inhibition of preadipocyte differentiation, increased adipocyte apoptosis, inhibition of lipogenesis in the liver and adipose tissue, and increased fat oxidation in the liver and adipose tissue. Several recent reviews have focused on these issues.

Obesity and Body Fat Loss

CLA supplementation has been shown to improve weight loss. CLA supplementation increased energy expenditure while decreasing body fat in animal studies. CLA stimulates the activity of carnitine palmitoyl transferase, an enzyme that transports fat into mitochondria for oxidation. CLA improves fat storage utilization while increasing the basal metabolic rate. The naturally occurring CLA can also improve the subjects' overall metabolic health. CLA may also increase bone density in animals, according to some studies.

Cardiovascular Disease Prevention

Natural CLA protects the heart by acting as an antioxidant and lowering blood pressure. It may prevent plaque formation and atherosclerosis by promoting the oxidation and utilization of body fat.

Cancer Avoidance

CLA has anti-carcinogenic properties and helps to prevent cancer formation. CLA is thought to influence prostaglandin synthesis and the fat-soluble vitamin pathway. It improves cellular function and thus helps to prevent neoplasia.

Conjugated Linoleic Acid in Food Applications

The increased interest in increasing CLA content in food products is attributed to its potential anti-carcinogenic, anti-diabetic, anti-atherogenic, and immunomodulatory functions in animals and humans. The health benefits of high-CLA milk and its products provide a niche market opportunity.

Dairy products and beverages concentrate on incorporating additional CLA as a functional food into diets because they naturally contain CLA. Aside from regular dairy products, milk-based beverages used in sports nutrition can improve athletes' endurance and positive weight regulatory mechanisms. CLA can be added to a variety of foods. Its potential market remains in meal replacement drinks, juices, smoothies, shakes, sports bars, cookies, and biscuits, where dairy products are freely used.

In this sense, consuming foods naturally enriched with CLA (rather than supplementation) over a lifetime would be an alternative to reducing excess adiposity. Furthermore, it may reduce the risk of other obesity-related diseases by ensuring beneficial effects on body composition without adding adverse health effects. Evidence suggests that CLA isomers affect blood lipids, tissue metabolism, cell functions, and transcription factors, which may improve health. However, studies with dietary supplements of various CLA isomers, either alone or in combination, have negatively affected human nutrition and health.

Concerns about the safety of CLA supplementation

CLA supplements may not be as beneficial as the natural form. They may also cause stomach aches, constipation, diarrhea, and nausea. Excessive CLA consumption can result in fatty liver, metabolic abnormalities, inflammation, and insulin resistance. As a result, dietary CLA may be considered a better option than artificial supplementation. However, the American FDA allows CLA to be added to foods and has granted it GRAS (Generally Regarded as Safe) status.

Despite studies on CLA supplementation in animals and humans to investigate changes in body composition and other benefits, they should be more discordant. CLA's ability to positively alter body composition by reducing fat mass has been demonstrated in experimental models and some human studies. Few studies have been conducted in humans to assess the effects of CLA alone or in combination with physical exercise on changes in body composition. As a result, the clinical evidence regarding the effects on body fat reduction needs to be more comprehensive, and significant side effects have already been described.

Conclusion

Conjugated Linoleic Acid is found in many foods, particularly milk and meat from ruminants such as cows, sheep, and goats. It is the only naturally occurring substance that has been shown to prevent cancer unequivocally. CLA's functional properties included increased energy expenditure, reduced body fat, and heart-friendly and anti-carcinogenic properties. It is also known to significantly reduce body weight by increasing lipolysis and fat oxidation. CLA can be fortified or enriched in a variety of foods. Aside from regular dairy products, sports nutrition products can also be aimed at incorporating CLA into diets. However, dietary CLA is preferable to artificial supplementation.

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