

Review Article

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Effect of Natural Food Components to Reduce the Risk of Obesity: A Review

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ABSTRACT

The role of nutritional factors or dietary elements is much more important which comprise balancing of energy between energy expenditure and intake or other factors that contribute to prevent obesity. Obesity is a noteworthy public health issue whose incidence tends to increase continuously. Emerging scientific data over the previous decade recommends that dairy foods might be advantageous when incorporated into a moderate energy limited diet and perhaps for weight management too. The improvement in functional foods used for the prevention and treatment of obesity assume an opportune time for the food market in addition to include the knowledge regarding mechanisms of energy expenditure and appetite as well as metabolic sensation of satiety. There are different natural product combinations that may affect in a synergistic movement which enhance their bioavailability plus action on several molecular targets, generating advantages in excess of chemical treatments. Various natural food components used in functional foods that give anti-obesity effect may include bioactive fatty acids, phenolic compounds, protein, phytochemicals, dietary calcium and dietary fiber.

Keywords

Nutritional factors,
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Introduction

Obesity is one of the major health issue seen in people worldwide, and it is widely accepted as a risk factor for several non-communicable such as, diabetes (Type 2), cardiovascular diseases and some cancers. The definition of obesity is given by World Health Organization (WHO) which is described as abnormal or excessive fat accumulation that may harmful

for health. It is depend upon person's body mass index (BMI) and waist to hip circumference ratio in which BMI is defined as the weight in kilograms divided by the height in meter squared (kg/m^2). This is an index that generally used to classify obesity and overweight in human due to its simplicity and easy to calculate. The value of BMI of 30 or more is normally considered as obese and BMI equivalent to or more than 25 is

considered overweight. It has been observed that in the previous 40 years, the incidence of obesity almost tripled and around 650 million people in the world, together with number of children and infants were obese in 2016 (WHO, 2018). It is primarily happen either due to insufficient physical activity or excess calorie intake or sometimes both. Furthermore, genetic, behavioral and also environmental factors contribute to initiate the obesity (James, 2008). As societies become progressively more dependent on energy-dense, big-portions and fast-food meals, the connection between fast-food utilization and obesity becomes additional concerning (Rosenheck, 2008).

Vincent and le Roux (2007) suggested that because of the multifaceted nature of obesity, there is no single or simple solution to combat this growing epidemic. Novel and most probably individualized interventions may be required to effectively treat and prevent obesity.

The best approach to address the epidemic of obesity is to understand the underlying mechanisms of appetite control, applying this knowledge to develop functional ingredients that can promote more significant weight loss and appear to be a promising idea to combat obesity in future. Some of the research studies have shown the beneficial health effects of consuming dairy products (i.e., fermented milks, yoghurt) on metabolic hazardous factors in obese individuals (Gonzalez *et al.*, 2012).

Pe'russe and Bouchard detailed that (2000) nutritional genomics could find out which specific nutrients convey phenotypic changes that impact on the risk of obesity and could set up an idea about which connections are the more significant for it. From dietary components, gut bacteria ferment indigestible carbohydrates, synthesized amino acids and

SCFAs (short chain fatty acids) that may probably contribute to provide the energy to the host (Nieuwdorp *et al.*, 2014; Backhed *et al.*, 2005). On the other side, modulated gut microbiota subjects with obesity appear to be more capable for the energy harvesting from the diet and may be contribute to decrease extra weight gain (Turnbaugh *et al.*, 2006).

Functional foods have been developed for weight control which involves the knowledge regarding body weight management system. Serrano and S'anchez-Gonzalez (2008) reported the most important strategies for weight management by incorporating different functional ingredients such strategies include stimulate energy expenditure (EE), food intake inhibition (by orexigenic signals inhibition or anorexigenic signals enhancement), limitation of bioavailability of nutrients (by digestive enzymes suppression) as well as modification of gut microbiota composition.

As per data shown in Table 1, scientists have studied the effect of natural food components (i.e., dietary fiber, calcium, fatty acids, plant sterols, soy protein) on body weight and obesity with their different mechanisms in both human and animals.

Such mechanisms include increasing fecal fat excretion, regulating adipocyte metabolism and TAG storage, regulating UCP2 expression, reducing LPL activity and increasing enzymes associates with β -oxidation of lipids, activating AMPK enzyme and phosphorylating hypothalamic STAT3, increase satiety through increase in circulating appetite regulatory hormones (e.g. GLP-1, CCK, PYY, GIP and insulin) that lead to reduce food intake, interfering with intestinal fatty acid absorption and some other mechanisms also with effective approach on decreasing food intake and enhancing satiety that reduce obesity level in both animals and human in addition to effectively prevent CVD.

Different natural food components used as anti-obesity agents

Calcium

It is one of the most significant dairy and food products components that may be related to obesity. Although reviews reported that ingestion of dietary calcium may lead to weight reduction (Dougkas *et al.*, 2011).

It is helpful in favor of the maintenance of blood calcium level, skeletal integrity in addition to decrease the risk of chronic diseases.

Some studies have recommended that a more ingestion of calcium might be increase emission of fecal fat and energy expenditure. The mechanism of expanding fecal fat emission is the most probably because of the development of unsolvable calcium-fatty acid soaps along with binding of bile acids (Bendtsen *et al.*, 2013).

Second mechanism reported (Shi *et al.*, 2001; Zemel *et al.*, 2000; Zemel, 2005) for intracellular Ca^{2+} in the regulation of adipocyte metabolism and TAG storage. It proposed that high measure of dietary calcium may possibly adjust circulating calcitriol levels.

Thus, suppression of calcitriol through high calcium diets decreased adipocyte intracellular Ca^{2+} , fatty acid synthesis, increased lipolytic activity and decreased adiposity (Trigueros *et al.*, 2013; Zemel, 2002).

Another mechanism explained the anti-obesity action of calcium that associated with the decreased calcitriol followed by calcium intake. This decreased calcitriol stimulate UCP2 expression, which thusly improved apoptosis of adipocytes (Sun and Zemel, 2004).

Protein

Protein is better and more satiating macronutrient than carbohydrate and also connected with a diet-induced thermogenesis. The dairy proteins mainly whey protein (WP) is noted to be more satiating than other protein source (casein and soy protein) and it may improve satiety via increases the circulating appetite regulatory hormones comprising GLP-1 (glucagon-like peptide-1).

Amino acids and bioactive peptides are generated from whey protein during digestion in gastrointestinal tract which increases the release of different hormones for example, cholecystokinin (CCK), peptide YY (PYY), gastric inhibitory polypeptide (GIP), GLP-1 and insulin that leads to reduced food intake and increased satiety. The effect of WP on satiety may be preferable due to the glycomacropeptide (GMP). There is a common consent that proteins moderate lipid absorption & synthesis and also stimulating lipid excretion (Khoury *et al.*, 2013).

A recent randomized controlled trial suggested that a combination of WP plus glucomannan (Glucomannan has important satiety effect following by gelification) has applied to decline in the craving to eat (decrease appetite) that is linked with enterohormonal modification (increase GLP-1) in spite of the low protein content (8 g) with glucomannan, which could decrease the speedy absorption of WP in relevance to the net forming throughout the gelification of the gastric condition (Sukkar *et al.*, 2013).

According to Baer *et al.*, (2011) the supplementation with whey protein concentrate (WPC) (~56 g/day) for six months without any dietary consult resulted in considerably lower fat mass, body weight along with waist circumference in obese people.

Fatty acids

Short chain fatty acids (SCFAs)

Obesity and amount of SCFAs in gut has direct relationship. These saturated aliphatic organic acids comprise of 1-6 carbons of which butyrate (C4), propionate (C3) and acetate (C2) are the mainly abundant ($\geq 95\%$) (Cook and Sellin, 1998). All of the individual SCFAs affect health differently. For example, acetate acts as a forerunner for cholesterol synthesis and lipogenesis whereas propionate has been reported to reduce acetate absorption into cholesterol (Hellerstein *et al.*, 1991).

Figure 1 represents the mechanism of effect of SCFAs in human. As per this mechanism, Canfora *et al.*, (2015) reported that SCFAs play significant role in the synchronization of energy metabolism and homeostasis. They can interact with G protein-coupled receptor (GPR) 41 and GPR 43, which are prompting an expansion in the intestinal emission of PYY and GLP-1 receptors that can enhance satiety (Hur and Lee, 2015).

In this mechanism, SCFAs are conveyed to the liver and changed over to triacylglycerol; these de novo synthesized lipids are saved in adipocytes and gut microbiota produce the circulating lipoprotein lipase (LPL)-inhibitor, Fiaf or Angptl4 (Backhed *et al.*, 2007). This LPL plays a vital role in hydrolyzing triglycerides (TGs) and discharging fatty acids that transport into adipocytes.

SFAs are re-esterified into TGs that further uptake and storage of tryglycerols in adipose tissue (Parekh *et al.*, 2014). A higher activity of the LPL clearly implies to higher storage of triacylglycerol and LPL enlarged within the adipose tissues of humans and rodents in obesity (Mattijssen *et al.*, 2014).

For example, Propionate can expand FFAs uptake, perhaps by influencing the LPL inhibitor ANGPTL4.

Both acetate and propionate may also decrease intracellular lipolysis by means of diminished hormone-sensitized lipase phosphorylation by synergistic with the SCFAs receptor GPR43 (Canfora *et al.*, 2015).

Furthermore, SCFAs appear to initiate AMP kinase in muscles, expanding insulin affectability, fatty acid oxidation as well as diminishing lipid growth (Plaza-Diaz *et al.*, 2019).

Pollyunsaturated fatty acids (PUFAs)

The prospective anti-obesity property of PUFAs might be described by their functions in the given aspects such as, in lipid metabolism, balance between energy ingestion and energy expenditure as well as status of neuroendocrine system and adipocytes.

It has been reported that PUFAs may possibly decrease the activity of the key enzymes liable for lipid synthesis i.e., stearoyl-CoA desaturase-1 and fatty acid synthase. Thus, they may keep away from entering adipocytes for lipogenesis and furthermore upgrade thermogenesis and lipid oxidation (Trigueros *et al.*, 2013). Diets for bovines with PUF (n3) plus polyphenols can naturally enriched milk with polyphenols and PUFAs (Santos *et al.*, 2016).

According to Santos *et al.*, (2017), they observed that this type of enriched milk as a complement to obese rats which has resulted in enlarged muscle mass and decreased LDL (low-density lipoprotein) values. Thus, PUFA-rich milk and normal whole milk have exposed to be helpful in a regular metabolic condition whereas milk enriched/fortified with polyphenols and PUFAs enhance metabolic effects on obesity to reduce it.

Dietary Fiber

There are various types of dietary fiber like,

cellulose, pectin, gum, soluble dietary fiber used in many anti-obesity products. In 1979, Heaton has found three mechanisms for action of dietary fiber that dietary fiber play crucial role to decrease energy intake and could act as a physiologic barrier. Such mechanisms include: (a) providing satiety and decreasing appetite; (b) food absorption inhibition in small intestine and (c) displacement of some other nutrients in the diet with dietary fiber. Several solvable dietary fibers (e.g., pectins, gums and B-glucans) become thicken while blending with liquids and it is beneficial on behalf of viscosity aspect because they are major benefactor to physiological sound effects in the small intestine. Expansion of viscosity may probably slow gastric emptying and holdup nutrient absorption. Moreover, Dietary fiber could be a fermentable substrate intended for the colon microbiota that supporting in the formation of SCFAs.

A lot of eventual studies have been highlighted that long-term utilization of fiber-rich food has a negative connection by means of body weight gain (Astrup *et al.*, 2010). Champagne *et al.*, (2011) examined the effect of changes in diet on body weight reduction and management. The conclusion was that increment of vegetables, fruits and low-fat dairy products containing dietary fiber may help to decrease weight gain. According to RDA (recommended dietary allowances), 35g/day of the dietary fiber is suggested or required for healthy adults.

Phytochemicals

Polyphenols are useful functional components that have anti-oxidant, anti-carcinogenic, anti-viral and anti-bacterial properties. In the earlier period from two decades, polyphenols have been reported to comprise beneficial effective property against obesity. For example, they could maintain adipocyte

metabolism to restrain the growth of adipose tissue (Baboota *et al.*, 2013). Flavonoids, stilbenes and phenolic acids are the widespread polyphenols which are being used in the enhancement of various natural food products for weight management. Phytosterols, which encompass plant-derived sterols and stanols, are compounds structurally similar to cholesterol. They present in dense concentrations in vegetable oils (e.g. soybean oil, sunflower oil and corn). Plant stanols and sterols have been proved be able to block the immersion of intestinal fatty acid along with decreasing weight gain in animal study (Gupta *et al.*, 2015).

The mechanisms concerned with phytochemicals on body weight include: (a) inhibition of propagation of precursor cells; (b) increase of apoptosis effect; (c) inhibition of pancreatic lipase activity and (d) increase in energy expenditure (Birari and Bhutani, 2007). Food products fortified with soybean are preferred as healthy food and also considered as significant part of the diet. Vij *et al.*, (2011) studied the soy protein and genistein supplementation in soy yoghurt that can reduce LDL (low density lipoprotein) cholesterol, total cholesterol as well as TGs levels in the liver and serum of mice which helps to decrease obesity level.

Conjugated Linoleic Acid (CLA)

In 2010, Kennedy and colleagues have studied that the linkage between obesity and gut microbiota lies in the capability of *Actinobacteria* and *Firmicutes* to generate CLA. Production of CLA is regarding within the situation of obesity as it has many anti-obesity effects such as, accumulated energy metabolism, lipolysis and energy expenditure as well as decreased lipogenesis and adipogenesis.

Table.1 Some natural food components with their prospective anti-obesity effect

Components	Effect in Human/Animals	Different mechanisms	References
Dietary Calcium	↓ Obesity in Human→? ↓ Obesity in animals	Increasing fecal fat excretion; regulating adipocyte metabolism and TAG storage; regulating UCP2 expression.	Zemel <i>et al.</i> , 2000; Zemel, 2002, 2005; Sun and Zemel, 2004; Christensen <i>et al.</i> , 2009; Astrup <i>et al.</i> , 2010; Derbyshire, 2010.
Dietary fiber	↓ CVD ↓ Obesity→ mixed results	Acting as a physiologic obstacle to energy intake; promoting secretion of anorexigenic peptides.	Liese <i>et al.</i> , 2005; Pereira and Ludwig, 2001; Murakami <i>et al.</i> , 2007.
CLA	↓ Obesity in animals ↓ Obesity in humans→ mixed results	Reducing LPL activity and increasing enzymes associates with β -oxidation of lipids.	Azain <i>et al.</i> , 2000; DeLany and West, 2000; Thom <i>et al.</i> , 2001; Meadus <i>et al.</i> , 2002; Silveira <i>et al.</i> , 2007.
PUFAs	↓ Obesity- ? ↓ CVD	Inhibiting key enzymes for lipid synthesis, increasing thermogenesis and preventing lipogenesis	Froyland <i>et al.</i> , 1997; Guo <i>et al.</i> , 2005; Liu <i>et al.</i> , 2005; Buckley and Howe, 2009; Melanson <i>et al.</i> , 2009.
Soy protein	↓ CVD ↓ Obesity in animals ↓ Obesity in humans→?	Isoflavon→modulating selective estrogen receptor activity. Peptides → activating AMPK and phosphorylating hypothalamic STAT3	Bhathena and Velasquez, 2002; Munro <i>et al.</i> , 2003; Velasquez and Bathena, 2007; Jang <i>et al.</i> , 2008; Cederroth and Nef, 2009.
Dairy Proteins (Whey/ Casein)	↓ FI and ↑ satiety ↓ Obesity in humans	Peptides → enhance satiety through increase in circulating appetite regulatory hormones comprising GLP-1, CCK, PYY, GIP and insulin lead to reduce food intake	Baer <i>et al.</i> , 2011; Khoury <i>et al.</i> , 2013; Pal <i>et al.</i> , 2014.
Plant sterols	↓ Obesity in humans→? ↓ CVD ↓ Obesity in animals	Interfering with intestinal fatty acid absorption.	Suzuki <i>et al.</i> , 2007; Takeshita <i>et al.</i> , 2007; Rideout <i>et al.</i> , 2010.

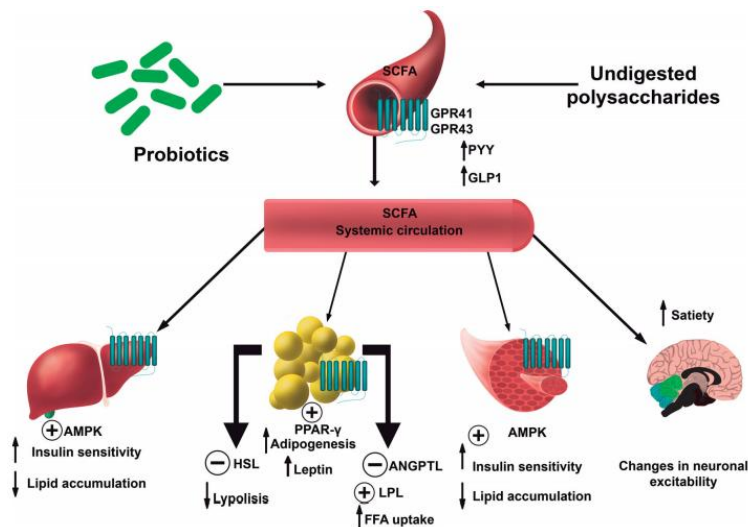
[Abbrev: TAG- triacylglycerol, UCP2- uncloping protein-2, CVD- cardiovascular diseases, CLA- conjugated linoleic acid, PUFAs- polyunsaturated fatty acids, AMPK- AMP-activated protein kinase, STAT3- signal transducers and activators of the transcription 3, FI- food intake, GLP1- glucagon-like peptide-1 , CCK- cholecystokinin , PYY- peptide YY, GIP- gastric inhibitory polypeptide, LPL- lipoprotein lipase, ↓ = decrease, ↑ = increase, ? = possible] (Source: Trigueros *et al.*, 2013)

Table.2 Some examples of food products fortified with potential bio-active components

Products	Sub-type	Bio-active components	References
Milk and Milk based products	Milk Milk shake, Milk shake powder Milk, Yoghurt, fermented milk (Low fat) Drinking yoghurt Fermented Milk Yoghurt Yoghurt	PUFAs PUFAs PS PUFAs Citrus fibers Isoflavones Green and black tea	Let <i>et al.</i> , 2005, 2007b; Clifton <i>et al.</i> , 2004; Hansel <i>et al.</i> , 2007 Nielsen <i>et al.</i> , 2009; Sendra <i>et al.</i> , 2008; Rossi <i>et al.</i> , 2008; Jim´enez <i>et al.</i> , 2008; Jaziri <i>et al.</i> , 2009
Juices	Orange juice Lemon juice	PUFAs Anthocyanins and otherphenolics	Lovegrove <i>et al.</i> , 1997; Gonz´alez-Molina <i>et al.</i> , 2008
Bakery products and Bread	Bread, biscuits, cake Bread, cereal Bread Bars	PUFAs PS PUFAs PUFAs	Clifton <i>et al.</i> , 2004; Yep <i>et al.</i> , 2002; Horn <i>et al.</i> , 2009; Nielsen and Jacobsen, 2009
Fish	Fish (heat-induced) gel Minced fish product	Inner pea fiber Fiber	Cardoso <i>et al.</i> , 2007; Cardoso <i>et al.</i> , 2010
Meat products	Dry fermented turkey sausage Pork sausages Raw sausage Dry-cured sausage	Green tea extract Green tea powder SPI Orange fiber	Bozkurt, 2006; Choi <i>et al.</i> , 2003; Porcella <i>et al.</i> , 2001; Fern´andez-L´opez <i>et al.</i> , 2008
Margarines and spreads	Spreadable fat Filling for sandwich cookies Low-fat spread	PUFAs PUFAs PUFAs	Kolanowsky <i>et al.</i> , 2004; Borneo <i>et al.</i> , 2007; Lovegrove <i>et al.</i> , 1997

[Abbrev: PUFAs- polyunsaturated fatty acids, PS- plant sterols, SPI- soy protein isolate] (Source: Trigueros *et al.*, 2013)

Fig.1 Potential biological effect of fatty acid oxidation in human (Source: Plaza-Diaz *et al.*, 2019)



Additionally, some investigations have suggested that CLA has ability to decrease de novo lipid synthesis along with adipocyte apoptosis (Obsen *et al.*, 2012).

It is observed that CLA mediates a number of effects by shifting arachidonic acid present in the phospholipids contained in cell membranes that diminishing the blend of eicosanoids like leukotrienes and prostaglandins well known factors in inflammation. Just as it has different signaling functions including activation of transcription factors and peroxisome proliferator-activated receptors (PPARs), which have downstream affected on lipid metabolism and immunity function (Belury, 2002). When study has been carried out on directed to mice, Mazloom *et al.*, (2019) reported that CLA improved nervous system activity which led to enhance energy metabolism and reduce adipose tissue.

Table 2 summarizes some bioactive food ingredients which have been reviewed and reported by different scientists that natural food products (i.e., milk and milk based products, bakery products, marine products, meat products, several juices, margarines and spreads) fortified using potential anti-obesity ingredients (PUFAs, SPI, PS, fibers, isoflavones, green tea powder) have shown anti-obesity properties.

Obesity is one of the epidemic public health issues worldwide, affecting both developing and developed countries. One of the solution of this public health issue is medical treatment to diminish the level of it in obese patients by using drugs which are presently available in the market but limited in efficacy and also few in number and although several drugs have promising anti-obesity effects, there are numerous perspectives within this research field that require further exploration. Besides this mechanism, one of the recent approaches to resolve this epidemic health problem is

utilization of natural foods that can play an effective and safe role especially those containing polyphenols, fibers, sterols and isoflavones in the prevention of obesity. Different potential activities of these natural products have been examined such as, regulate metabolism, fat absorption by the body, act as general body cleanser, energy booting and help in constipation, help to eliminate hunger during the treatment of obesity. Physiological, behavioral and environmental contributions all can be influence to initiate obesity.

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