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Health benefits and importance of *Avena sativa* L

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Abstract
Avena sativa L., popularly known as "oats". It is said to be unique among all cereals because it is therapeutically active against many metabolic, and gastrointestinal diseases, inflammatory diseases, and vascular injuries such as obesity, diabetes, hypertension, dyslipidemia, constipation, and cancers etc. The nutritional composition of oats is more than any cereal. It has more dietary fiber, protein, zinc, and iron. This review highlights the health benefits, importance, nutritional composition, and the future of oats in the health continuum.

Keywords: *Avena sativa* L., health, nutrition, dietary fiber

Introduction
Avena sativa is popularly known as "oats". It is considered one of the richest sources of dietary fiber. It belongs to the "Poaceae" family. Its first evidence was found in Egypt and ancient Switzerland. There are thirteen species and subspecies of Avena. All the species are recognized by the U.S. Department of Agriculture Technical Bulletin 1100. Among all thirteen species of oats, the most commonly cultivated species is "*Avena sativa*". It contributes about 75% of the total cultivation [1].

Nutritional value of oats
Both oat whole grain and oat bran contain a significant amount of protein i.e. 15-17% and 15-18% respectively. Also, it contains a high percentage of balanced amino acids. The starch and sugar content of oats whole grain and bran is 59-70% and 10-50% respectively. The major portion of the grain is soluble in salt, thus classified as globulin and a small portion is soluble in albumin and alcohol-soluble prolamin. Furthermore, it has 4.5-6.5% of dietary fiber, 2-6%, 5-20% of beta-glucan, 14%, 2.5% of cellulose, and 2.4, 4.5% of lignin in whole grain and oat bran respectively. Moreover, it is a good source of essential unsaturated fatty acids [2, 3].

Effects of oats on insulin resistance
Addressing insulin resistance, the primary component and underlying factor of metabolic syndrome linked to type 2 diabetes, is a crucial focus in the therapeutic utilization of oat β-glucans. Consuming adequate amounts of total, soluble, and insoluble fiber in the diet is linked to a lower prevalence of insulin resistance. This reinforces the idea that a diet rich in fiber is connected to improved insulin sensitivity [4, 5]. Oat β-glucans promote heightened glucose absorption into skeletal muscle, enhancing insulin sensitivity through the delayed emptying of the stomach [6]. These delays, attributed to their high viscosity and stability at varying pH levels, facilitate a gradual absorption of dietary glucose [7]. The observed decrease in glucagon response following oat extracts may contribute to the reduction in glucose concentrations [8]. Oat β-glucans may potentially lower blood glucose levels by engaging a signaling pathway that involves the activation of PI3K/Akt. Research indicates that the consumption of approximately 5 grams of oat β-glucan per day can result in a 50% reduction in the glycaemic response following the ingestion of 35 grams of carbohydrates. Additionally, in a 50-gram carbohydrate portion, each gram of β-glucan correlates with a decrease of 4 units in the Glycaemic Index (GI) [9, 10]. Following the consumption of oat (bran flour or crisp), blood glucose levels were observed to be lower at 15, 30, and 45 minutes. However, there was an increase in blood glucose levels at the 90-minute mark after a 12.5-gram glucose load [11].

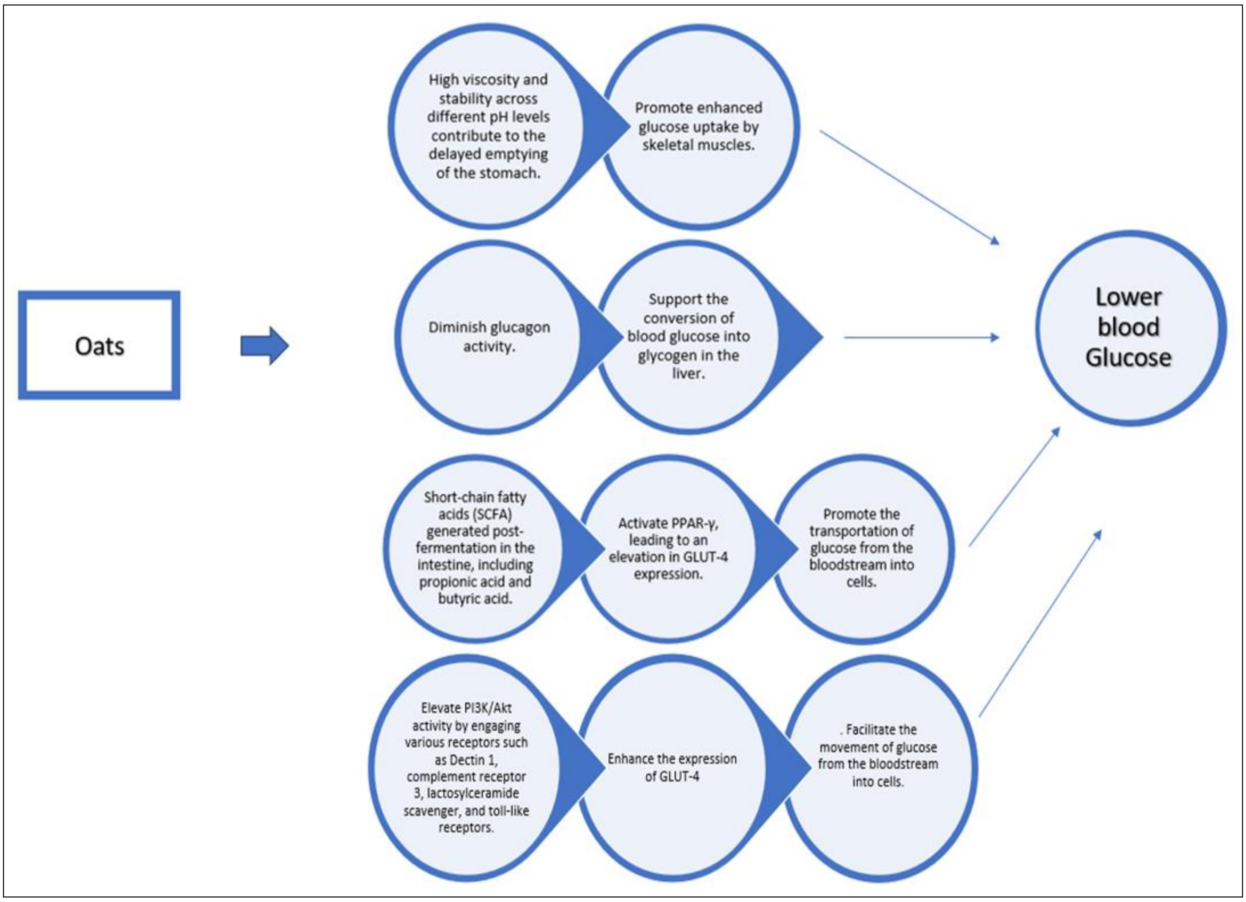
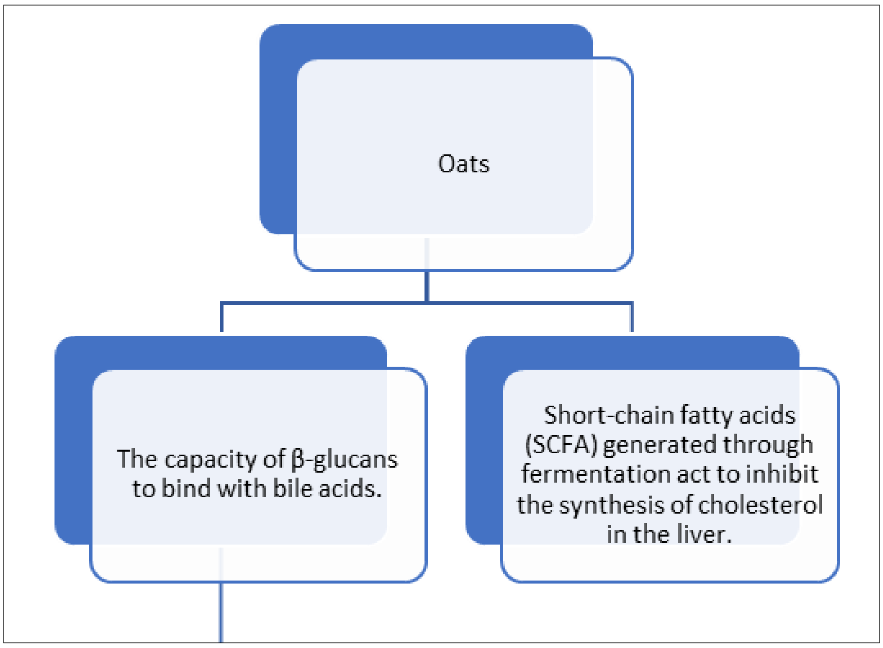


Fig 1: The mechanism through which oats exert their effects against diabetes

Effects of oats on Dyslipidemia

Research has demonstrated that β-glucans can lower LDL cholesterol and elevate HDL, potentially mitigating dyslipidaemia and reducing the risk of cardiovascular disease (CVD) [12, 13]. It has been found that β-glucans, with a required dose of 0.75 g per serving in food, have a cholesterol-lowering effect. Oats were initially discovered to possess this beneficial effect, and further research identified β-glucans as the active component responsible for the cholesterol-lowering properties [14]. Based on numerous clinical studies, the US Food and Drug Administration (FDA) has authorized the claim that oat-soluble fiber can lower the risk of heart disease.

Oats have demonstrated the ability to decrease both serum total cholesterol and LDL cholesterol levels in comparison to control groups [14-17]. Studies indicate that for every 1% decrease in LDL (low-density lipoprotein), the associated risk of coronary heart disease (CHD) is reduced by 1% to 3% [18]. Additionally, oat β-glucans undergo fermentation by human fecal microbiota, generating short-chain fatty acids like acetate, propionate, and butyrate. Following absorption into the portal vein, both acetate and propionate act to inhibit hepatic cholesterol synthesis, contributing to the hypocholesterolaemia effect [19].



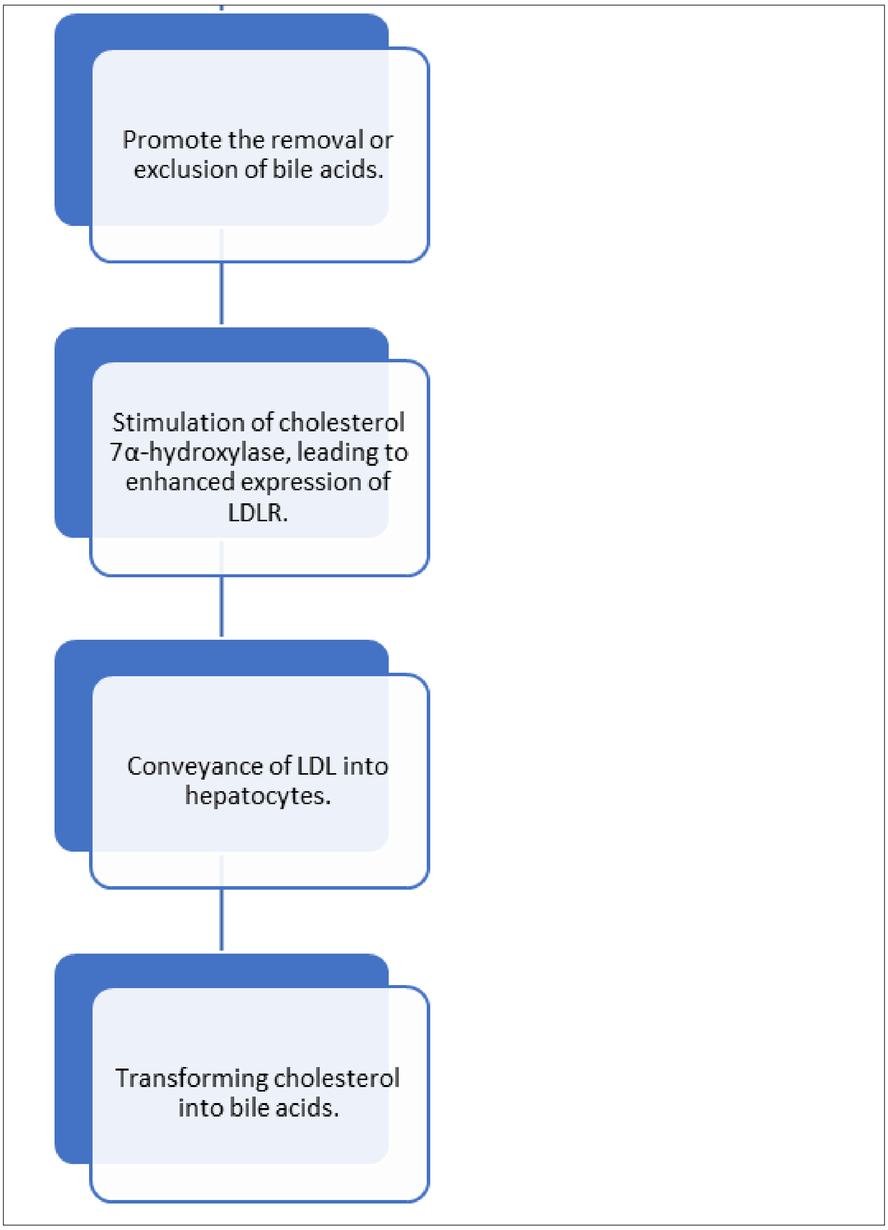


Fig 2: Oats' role in addressing Dyslipidemia

Effects of oats on satiety

Epidemiological evidence indicates a correlation between regular consumption of whole-grain foods, including oats, and a lower Body Mass Index (BMI) [20]. While whole-grain foods, like oats, are generally believed to induce satiety because of their elevated fiber content compared to other grains, a recent systematic review has presented findings that challenge this assumption [21]. Research focusing on oats or β-glucan within beverages, soups, or cooked oatmeal has demonstrated greater consistency in outcomes concerning hunger and fullness, indicating a more reliable measure of satiety response. These findings imply that the hydration of oat fibers might be a crucial factor influencing their satiety response. For instance, research indicates that an isoenergetic oat-bran-based beverage with high viscosity generates heightened satiety responses when compared to a low-viscosity oat-bran beverage treated with β-glucanase [22-24].

Dietary fibers can influence satiety and contribute to weight loss through various mechanisms, as proposed by Anderson (1990) [31]:

- **Extended Eating Time:** High-fiber foods take longer to consume, promoting increased feelings of satiety and satisfaction.
- **Delayed Gastric Emptying:** Fibrous foods slow down the emptying of the stomach, leading to a prolonged sense of fullness.
- **Reduced Insulin Levels:** Fiber intake may lower serum insulin, diminishing hunger as insulin typically stimulates appetite.
- **Reduced Nutrient Absorption:** High-fiber foods may decrease nutrient absorption, providing less energy compared to low-fiber alternatives.
- **Increased Thermogenesis:** Fiber-rich foods might elevate dietary thermogenesis rates compared to low-fiber counterparts.
- **Fermentation Products:** The by-products of fiber fermentation, such as gas and short-chain fatty acids (SCFAs), could act to decrease overall food intake.
- **Peptide Release Stimulation:** Fiber consumption may stimulate the release of peptides that influence feeding behavior.
- **Improved Diet Adherence:** Including fiber in the diet may enhance adherence to dietary plans [25].

Effects of oats on colon motility and constipation

Compared to other sources of dietary fiber, there is a limited number of clinical studies investigating the impact of oat fiber on colon motility and constipation. Clinical studies, consistent with findings from animal studies, indicate that oat soluble fiber contributes to an increase in fecal wet weight and a reduction in total transit time. The bulking effect and the rise in stool dry weight primarily result from the presence of insoluble fiber, which remains largely intact throughout the gastrointestinal tract. The decomposition of β-glucan in the large intestine is a key factor contributing to the higher increase in wet weight compared to ingredients predominantly containing insoluble fiber. This notable effect is primarily attributed to the rise in microbial cells, as evidenced by studies conducted in both animal and human subjects. Similar to other fiber sources that serve as substrates for fermentation in the large intestine, oat soluble fiber can lead to the evolution of gas, particularly when there is a sudden change in the amount invested in the diet. In comparison to wheat bran, oat bran is reported to induce less discomfort and result in reduced formation of hydrogen and methane [26]. The mechanism by which short-chain fatty acids (SCFAs) operate may include interaction with the enteric nervous system and mucosal chemoreceptors. Alternatively, it could involve the release of regulatory peptides from entero-endocrine cells or a direct response on the intestinal smooth muscle cells [27]. Short-chain fatty acids have demonstrated the ability to dilate arterial capillaries, potentially influencing blood flow and absorption rates from the colon. Beyond the quantity of β-glucan, the physicochemical status of this compound holds significant importance for its physiological function. The manufacturing processes for high β-glucan oat products and their integration into foods should be meticulously designed to prevent the decomposition of the molecule and facilitate rapid solubilization of β-glucan [28].

Effects of oats on hypertension

Oats are widely recognized as a heart-healthy cereal due to their rich nutritional profile. As a highly nutritionally dense cereal grain, oats encompass various bioactive compounds, including dietary fibers, phenolic compounds, high-quality proteins, and unsaturated fats. With numerous substantiated health claims in several countries, oats have been associated with reducing blood cholesterol levels and managing postprandial glycaemic responses. This effectiveness positions oats as a valuable ally in combating chronic diseases such as cardiovascular disease and its risk factors, including diabetes, hyperlipidemia, and hypertension [29]. In a randomized controlled human trial, done on 88 patients, on base feeding of oats cereals, a notable outcome was observed, where 73% of participants in the oats group, in contrast to 42% in the control group, were able to either discontinue or reduce their medication by half. Even among those in the treatment group whose medication wasn't reduced, significant decreases in blood pressure were evident. The oats group exhibited substantial improvements, including a reduction of 24.2 mg/dL in total cholesterol levels, a decrease of 16.2 mg/dL in low-density lipoprotein cholesterol levels, and a 15.03 mg/dL drop in plasma glucose levels compared to the control group [30].

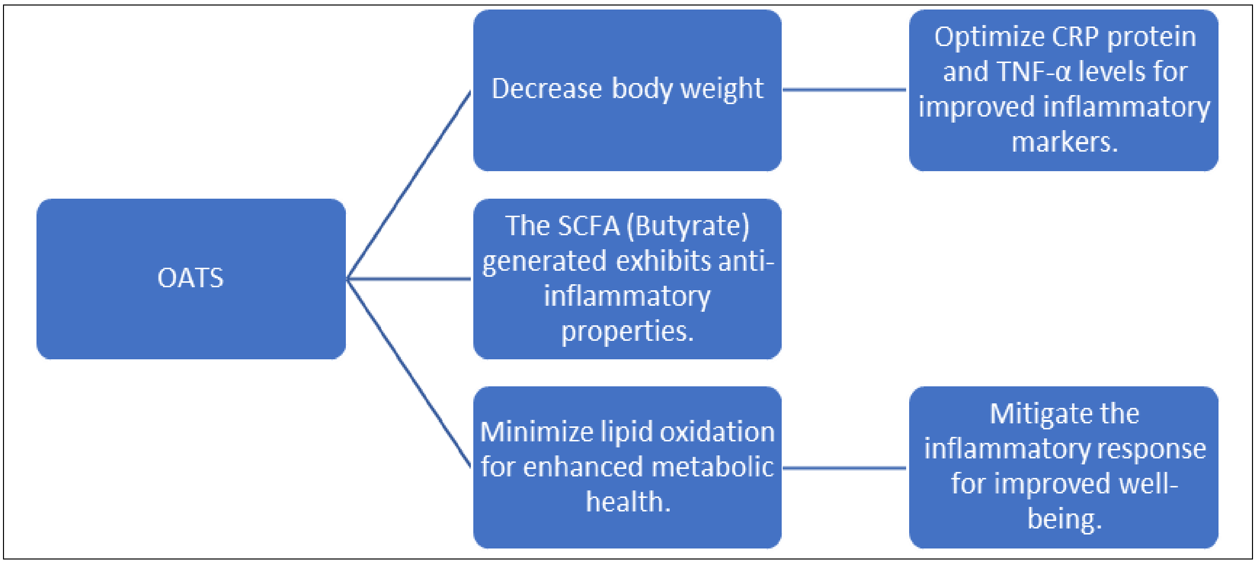


Fig 3: Oats exhibit anti-inflammatory properties to counteract proinflammatory processes

Conclusion

Oats, widely embraced by consumers worldwide, feature prominently in a diverse array of food products, spanning low-energy beverages, medical foods, baked goods, and granolas. Against the backdrop of escalating global food-security concerns and the dual health challenges of both overweight and underweight populations, oats emerge as a potential component in cost-effective and nutritious products for the future. International dietary guidelines advocate an increased intake of whole grains for enhanced health, with oats standing out as a distinct and beneficial type of whole grain. Their evidence-based impact on cardiovascular disease (CVD) risk is noteworthy, and ongoing research may reveal additional benefits related to gut health and certain forms of cancers.

While the acute effects of oat consumption on satiety and glucose management are more evident, exploring the long-term impacts presents essential avenues for both basic and applied research in human health and nutrition. The manifold benefits of oats underscore the importance of expanding agricultural practices and cultivar assessments, especially to ensure oats' resilience in stress-laden environments and against common pathogens. Furthermore, exploring processing technologies is crucial to maintaining the nutritional qualities and health attributes of oats, ensuring their continued availability as a global commodity for a growing population. In response to escalating medication costs and concerns about side effects, consumer interest is increasingly shifting toward dietary modifications to enhance health. Oats, well-documented for their efficacy against prevalent lifestyle disorders, offer a unique combination of proteins, fats, dietary fibers, minerals, vitamins, and alkaloid polyphenols. Oats serve as an excellent substrate for the growth of probiotic lactic acid bacteria, thereby amplifying their potential to improve consumer health and well-being. While lactic acid fermentation of oats is an ancient processing method, the majority of oat-based products in the market are non-fermented. Even among fermented products, a predominant trend is their non-dairy composition.

In the stomach and small intestine, oat-soluble fiber, particularly β-glucan, primarily operates by increasing the viscosity of gastric and intestinal contents. This action is mediated through neuro-hormonal systems involving both endocrine and gastrointestinal hormones. In the colon, the principal role of β-glucan is as a substrate, promoting the production of butyric acid. Oligosaccharides derived from β-glucan have been shown to act as selective factors, supporting the growth of certain probiotic bacterial strains. The positive impact on colon function is attributed partly to the enhanced production of microbial mass with favourable water retention properties and partly to the bulking effect of the insoluble components of the fiber.

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