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Therapeutic benefit of dietary inulin

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Abstract
The carbohydrates known as non-digestible oligosaccharides (NDO) include inulin-fructooligosaccharides (FOS), which have been consumed by humans for a very long time. In vitro and in vivo research have demonstrated that inulin has several nutritional benefits, primarily related to the stimulation of bifidobacteria. Similar to dietary fiber, inulin shares all the properties and health advantages of non-digestible polysaccharides (NDP). The normal physical effects of dietary fiber, including significant increases in osmotic pressure, intestinal bulking effects, intensive water holding, and dramatic viscosity building, are not present in inulin.
The capacity of inulin to specifically promote the growth of bacterial genera and species known to be health-promoting in vivo in humans, such as Bifidobacterium (apart from Bifidum) and Lactobacillus, at the expense of potentially harmful microorganisms, accounts for a number of the vitamin's more notable health benefits. Therefore, inulin is typically regarded as a bifidogenic factor prebiotic. Prebiotics, such as inulin, have the advantage of promoting the selective growth of endogenous bacteria in their natural habitat, without being overly impacted by their surroundings, unlike probiotics.
Inulin can be referred to as a "physiologically functional food" or food ingredient, or simply a food with potential health-promoting effects, due to its effects on gut microbiota, blood glucose attenuation, lipid homeostasis, mineral and nitrogen bioavailability, immunomodulation effects, and the ability to add texture and improve rheological characteristics and nutritional properties of food.

Keywords: *Inulin, health benefits, lipid profile, Dairy Products.*

Inulin

Inulin was identified as a carbohydrate compound when it was isolated by Rose in 1800 from the roots of the Greek oleander plant, Inulahelemum, belonging to the Asteraceae family (Hala and Soha, 2017). Inulin is a homogeneous mixture of fructose sugar units, which occurs naturally as a carbohydrate reserve in plants (Shorideh *et al.,* 2016). It is present in the form of intercalated units with secondary fructose units linked by β (1-2) bonds, ending in a single glucose molecule. The degree of polymerization of this sugar ranges from 2-60. Inulin represents a group of naturally occurring polysaccharides produced by several plant species, and its primary industrial source is chicory. Inulin is a dietary fiber called fructan, which is used as an energy store in some plants and is commonly found in roots and rhizomes. Most plants that produce and store inulin are devoid of other carbohydrates, such as starch. Common sources include fruits, vegetables, herbs, wheat, onions, bananas, leeks, dahlias, and cauliflower (Cooper *et al.,* 2016). Figure (1) illustrates the structural formula of inulin. It is considered a natural food substance according to all European Union legislation, as well as US legislation (Vandeputte *et al.,* 2017).

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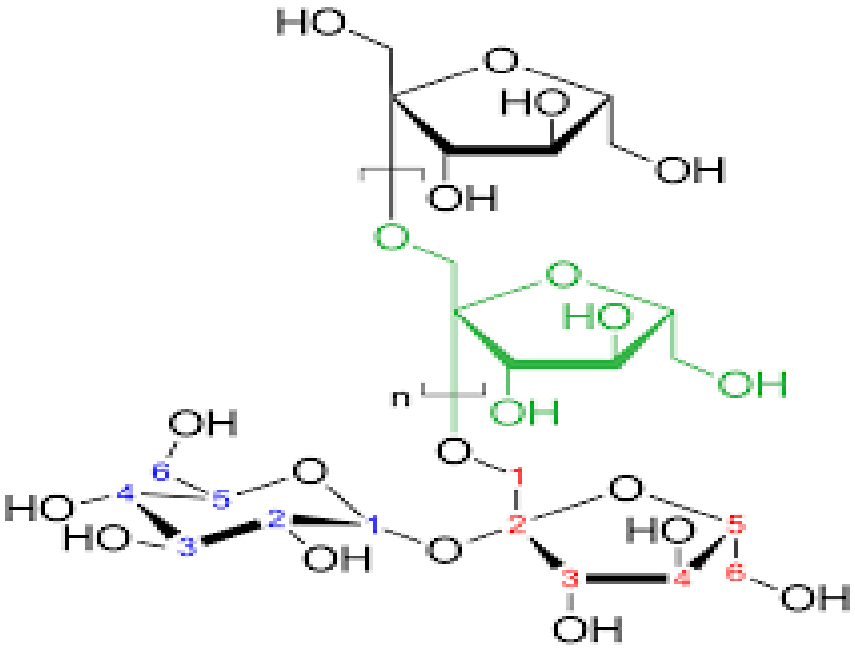

The health benefits of inulin

Inulin is resistant to digestion and degradation in the human intestine due to its beta (1-2) bonds. Therefore, it is considered an energy-reducing compound (Mohamed *et al.*, 2017). It is only utilized by bacteria once it enters the intestine, where it significantly contributes as a prebiotic for the growth of therapeutic bacteria (Bifidobacteria), which contribute to improving overall health. Inulin does not raise absorbable glucose levels and therefore does not increase insulin secretion (Vandeputte *et al.*, 2017). Inulin is not digested by digestive enzymes in the stomach, but is fermented by colonic bacteria in the large intestine through short-chain fatty acids and carbon dioxide. Inulin is also considered a low-calorie carbohydrate, providing less than 50% of the energy provided by other digestible carbohydrates (Shehzad *et al.*, 2017).

Vandeputte *et al.*, (2017) reported a significant decrease in triglyceride content in both the blood and liver of laboratory rats when inulin was added to their diets containing saturated fats. Inulin increases the bioavailability of mineral salts, possibly due to its osmotic effect on water transported within the large intestine. They also observed an increase of approximately 60% in calcium and magnesium absorption levels when rats were fed a diet containing chicory inulin (Nicola *et al.*, 2015).

Recommended amounts of inulin in foods

Currently, inulin intake in Western Europe ranges between 2-12 grams per day (Meyer *et al.*, 2011). In the United States, intake is estimated to be between 2-8 grams per day, based on a 2014-2015 U.S. Nationwide Food Consumption Survey (Gonzalez-Herrera *et al.*, 2015). A study conducted by the USDA showed that the recommended intake of inulin varies by age, ranging from 1.3 grams for young children to 3.5 grams for adolescent boys and adults, or an average of 0.9-1.5 grams per 1,000 calories. Its main sources are wheat (69%), onions (23%), bananas (3%), garlic (15–20%), and other foods (2%) (Moshfegh *et al.*, 2016). The average intake of inulin in French adults is estimated at 16 g/day. The daily recommendations for undigested polysaccharides prepared by the WHO (2016) are 16–24 g/day, which corresponds to 1–5% of chicory extract. In the UK, it is 12–24 g/day, similar to the estimate of 10 g/1000 kcal. This is recommended by the Life Science Research Office Expert Panel (LSROEP). Inulin is added at a rate of 5-15% to breakfast cereals and rice, and is mixed with dough during manufacturing (Hala and Soha, 2017) and with fermented dairy products. It is also used in the encapsulation of some food products to deliver

them to the colon without change or digestion by forming a coating layer (Vandeputte *et al.*, 2017). Table (1) shows the proportions and functions of inulin and polysaccharides in some food applications.

Application	Functionality	Dosage level inulin (% w\w)	Dosage level oligofructose (% w\w)
Dairy products	Sugar and fat replacement Synergy with sweeteners Body and mouthfeel Foam mobility Fibre and prebiotic	2-10	2-10
Frozen desserts	Sugar and fat replacement Texture and melting Synergy with sweeteners Fibre and prebiotic	2-10	5-12
Table spreads	Fat replacements Texture and spreadability Emulsion stability Fibre and prebiotic	2-10	-
Baked goods and Breads	Fibre and prebiotic Moisture retention Sugar replacement	2-15	2-25
Breakfast cereals	Fibre and prebiotic Crispness and expansion	2-25	2-15
Fillings	Sugar and fat replacement Synergy with sweeteners Body and mouthfeel Fibre and prebiotic	2-30	2-50
Fruit preparations	Sugar replacement Synergy with sweeteners Body and mouthfeel Fibre and prebiotic	2-10	2-50

Uses of Inulin in Food and Dairy Products

Inulin is used as a functional food ingredient in a number of foods, such as bakery products, desserts, ice creams, beverages, and dairy products, particularly yogurt made from 0.1% fat skimmed milk. The low or reduced fat content of yogurt affects its flavor and texture, which encourages the addition of inulin as a healthy alternative to fat (Guggisberg *et al.,* 2009). Inulin is currently used in food manufacturing, particularly in the functional food industry, due to its nutritional benefits. It has a number of physiological, metabolic, hormonal and immunological effects, making it beneficial for human health due to the possibility of its stimulation by the probiotics naturally present in the human digestive system. This is known as the probiotic effect. These probiotics are not digested or absorbed in the upper part of the digestive system, but rather ferment in the upper part of the intestine by these organisms, which leads to increased growth of Bifidobacteria and Lactobacilli (Rastal, 2009). There has also been growing interest in adding inulo-oligosaccharides to the food industry as a fat substitute and therapeutic product. Inulin is an important substance in biological processes. Commercial production of inulin has been developed from chicory roots using physical, chemical, and enzymatic processes, resulting in a product with a limited degree of polymerization and distinctive properties Zhang *et al.,* 2010).

Kaminskas *et al.,* (2013) reported that low-fat yogurt enriched with inulin had better texture, flavor, and consumer acceptance than low-fat yogurt, while explain the high concentrations of inulin increased the feeling of fullness in yogurt. El-Nagar and Brennan (2001) studied the effect of several types of stabilizers on the rheological properties of yogurt. They used concentrations of 2, 4, and 6% inulin, 0.2, 0.4, and 0.6% carboxymethyl cellulose, and 1, 2, and 3% pea fiber. The starter cultures were not affected by the types or concentrations of stabilizers used, but the rheological properties were affected by both the quality and concentration, demonstrating the effect of stabilizers on the consistency and composition of yogurt and preventing whey from leaching or separating from it. The results showed that using inulin at a concentration of 2% gave the best results compared to the other treatments in terms of consistency and consumer acceptance. Guven *et al.,* (2005) compared control yogurt made from whole milk with yogurt made from skim milk enriched with 1, 2, and 3% inulin. They found that adding more than 10% inulin increased whey separation and negatively affected texture and sensory evaluation. Furthermore, yogurt samples containing 1% inulin and 0.1% fat showed similar properties to the control treatment containing 3% milk fat.

Shehzad *et al.,* (2017) added inulin to increase viscosity and provide a good texture to low-fat and fat-free products such as yogurt, salad dressings, and chocolate.

Kip *et al.,* (2006) found that inulin improved the creaminess and apparent viscosity of low-fat whipped yogurt. Rafter *et al.,* (2007) reported that foods enriched with L. *rhamnosus* and B. *lactis* with inulin reduced the incidence of cancer. L. *casei* counts increased significantly in lactic fermented cultures when enriched with probiotics such as short-, medium-, or long-chain inulin Wada *et al.,* 2005). studied the effect of sucrose, fructooligosaccharide (FOS), inulin, and skimmed milk on the viability and activity of L. *reuteri* TMW1.106 during freezing, lyophilization, and storage. The results showed significant differences in the effects of the aforementioned probiotics on L. *reuteri* resistance during freezing and storage, with both inulin and skimmed milk having a positive effect on maintaining bacterial cell resistance. FOS also increases the resistance of bacterial cell walls to drying and moisture loss during lyophilization. Mishra and Mishra (2018).

Olivera *et al.,* (2011) reported that fortifying skimmed milk with low concentrations of inulin can improve the growth and viability of L. *acidophilus*, L. *rhamnosus*, and Bifido lactis bacteria in fermented skimmed milk. Therefore, inulin can be considered a fat substitute in functional dairy products, as they have similar sensory properties.

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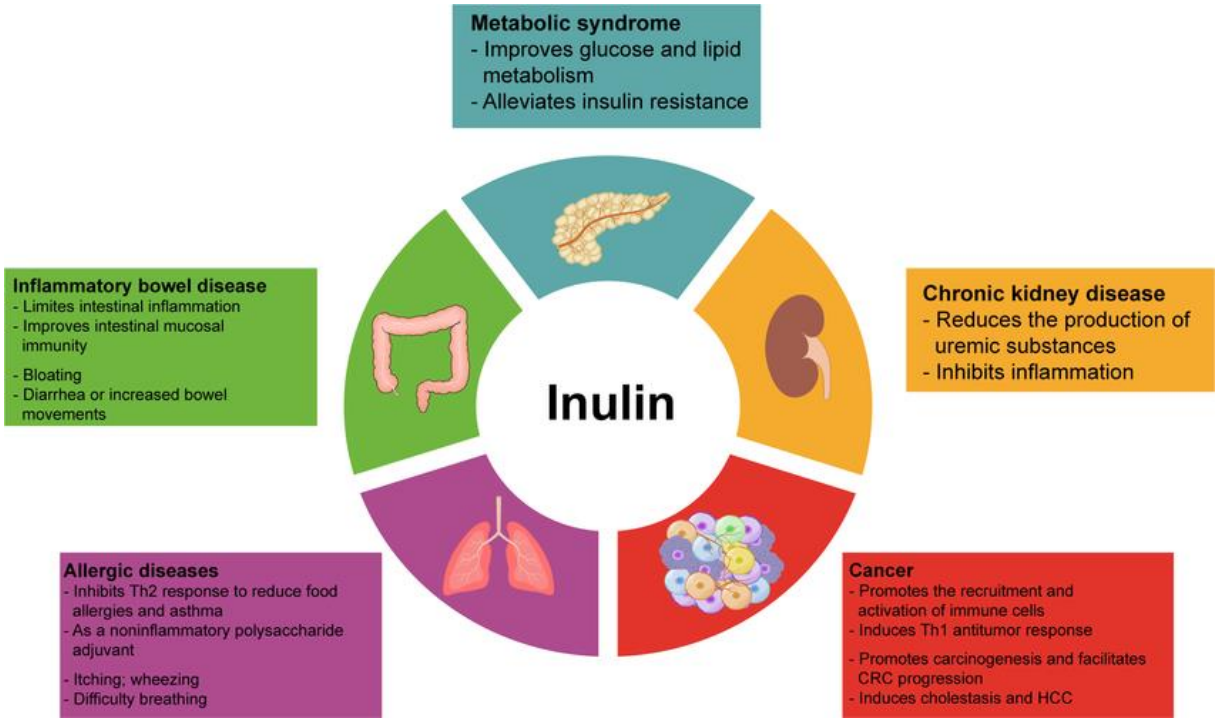

Figure (2) beneficial of inulin
Sheng and Zhang (2023).

Manufacturing and Physical Properties of Inulin

Chicken inulin is available as a white, odorless powder, while oligofructose (oligosaccharides) produced from chicory are available as powder and as a colorless, viscous syrup (75% solids). All are available in high purity and have known chemical compositions.

Inulin generally has a mild taste, free of any off-flavor, and leaves no aftertaste. Standard inulin has a slightly sweet taste (10% sweetness compared to sucrose), while superpolymerized inulin (from which polymerization fractions below 10 have been removed) is not sweet and does not require any modification of food components to bind to it (Chawla and Patil, 2010). Inulin has exceptional potential as a fat substitute. When mixed with water or other solution as a 100% fat substitute, the gelatinous particles form a network, producing a creamy, white structure with a dispersible texture that can easily be incorporated into foods (Mohammed *et al.,* 2017).

Gels consist of a three-dimensional network of crystalline, water-insoluble inulin molecules with a size of submicrons. Large amounts of water are present within this network, ensuring the physical stability of inulin. Inulin works synergistically with most gelatinous compounds, such as gelatin, alginate, maltodextrin, gellan gum, and carrageenan. Inulin improves the stability of foams and emulsions, such as whipped toppings, ice cream, and sauces, and thus serves as an alternative to other stabilizers in various food products (Maarten *et al.,* 2015). Pure crystalline inulin has a specific gravity of 1.35 with an average molecular weight of 1600 Daltons. Commercial inulin has a sweet taste due to its small content of mono- and disaccharides. Inulin's solubility in water depends on the degree of polymerization and the degree of chain branching. It is soluble at approximately 60 g/L at 10°C, while the amount increases to 330 g/L at 90°C. Under normal conditions, it is dispersible in water and sometimes has a tendency to aggregate when dissolved in water. Its dispersion properties can be improved by mixing it with sugars or starch. Inulin's water-binding capacity is 1:1.5 (Shehzad *et al.,* 2017).

Effect of Inulin on Blood Lipids and Cholesterol

Sources have indicated the effect of inulin and its relationship to lipid metabolism. Daily feeding of rats with 10% inulin for one week resulted in a significant reduction in serum triglyceride levels (Stellaard *et*

al., 2016). Schonewille *et al.,* (2016) confirmed that rats fed diets containing 10% and 29% polyfructose reduced serum triglyceride levels. They also indicated a decrease in cholesterol, mainly a decrease in very low-density lipoprotein (VLDL), while high-density lipoprotein (HDL) increased. Stellaard and Lutjohaan (2017) concluded that inulin has the ability to reduce lipid levels when consuming a high-fat diet, as it prevents the accumulation of triglycerides and cholesterol and reduces the fat content to a greater extent compared to experimental animals fed a high-fat diet. When 10% inulin was added, it reduced triglycerides and very low-density lipoprotein (VLDL) by: Inhibition of the key enzyme glycerol-3-phosphate aceyltransferase (G3P) in fatty acid synthesis. In a study conducted by Kozmus *et al.,* (2017) on two treatments, the first by adding 10% inulin and the second by adding 10% polyfructose to rat diets for 7 weeks, both resulted in a significant reduction in serum cholesterol and abdominal fat, as well as an increase in intestinal length compared to the control treatment. In a study conducted by Kim and Shin (2014) on rats, 0.2% cholesterol was added to the diets of treatments containing 1% and 5% chicory extract, as well as the diet containing 5% inulin powder for 4 weeks. This study showed a significant increase in serum high-density lipoprotein (HDL), and a significant decrease in liver cholesterol and low-density lipoprotein (LDL) levels in the serum of the three treatments compared to the control. It also significantly increased the excretion of fat, cholesterol, and bile salts in the feces of the treatments compared to the control group. The effect of inulin on lipid metabolism in humans varied depending on the presence or absence of chronic diseases. In a 14-day study on diabetic patients, consuming 8 g of polyfructose with a coffee drink reduced cholesterol by 19 mg/dL and low-density lipoproteins significantly by 17 mg/dL. In a study conducted by Causey *et al.,* (2014) on 12 men with high cholesterol, serum triglycerides were reduced by 40 mg/dL when consuming 20 g of inulin from chicory extract, reducing serum cholesterol by 11 mg/dL, and LDL was also reduced. In a study of 21 male and female volunteers with high cholesterol, who consumed 18 grams of inulin daily with a low-fat diet for 4 weeks, a significant decrease in LDL cholesterol was observed, amounting to 4.4%, and total cholesterol, amounting to 8.7%.

The health importance of inulin

Inulin is characterized by its resistance to digestion and decomposition in the human intestine due to its composition containing beta (2-1) bonds, so it is considered an energy reducer (Mohammed *et al.,* 2017). as bacteria benefit from it only when it enters the intestine, as it contributes significantly as a bio-enhancer for the growth of therapeutic bacteria (*Bifidobacteria*) that work to improve general health. Inulin does not cause an increase in the level of absorbable glucose and thus does not increase insulin secretion (Vandeputte *et al.,* 2017). Inulin is not digested by digestive enzymes in the stomach, but is fermented by colon bacteria in the large intestine through short-chain fatty acids and carbon dioxide. Inulin is considered a low-calorie carbohydrate because it provides less than 50% of the energy provided by other digestible carbohydrates Shehzad *et al.,* (2017).

(Vandeputte *et al.,* 2017) indicated a significant decrease in the content of triglycerides in both the blood and liver of laboratory rats when inulin was included in their diet containing saturated fats. Inulin increases the bioavailability of mineral salts, and this may be due to its osmotic effect on the water transported inside the large intestine. It was also noted that there was an increase of about 60% in the levels of calcium and magnesium absorption when rats were fed a diet containing chicory inulin (Nicola *et al.,* 2015).

Effect of inulin on blood lipids and cholesterol Sources have indicated the effect of inulin and its relationship to lipid metabolism. Daily feeding of rats with 10% inulin for one week resulted in a significant reduction in the level of glycerides in the blood serum Schonewille *et al.,* (2016) confirmed that rats fed a diet containing 10% and 29% polyfructose reduced serum cholesterol levels. He also indicated a decrease in cholesterol, mainly a decrease in very low-density lipoprotein (VLDL), while high-density lipoprotein (HDL) increased. Stellaard and Lutjohaan (2017) concluded that inulin has the ability to reduce lipid levels when consuming a high-fat diet, as it prevents the accumulation of glycerides and cholesterol and reduces the fat content to a greater extent compared to experimental animals fed a high-fat content. When 10% inulin was added, it reduced glycerides and very low-density lipoprotein (VLDL)

by: Inhibition of the key enzyme Glycerol-3-phosphate aceyltransferase in the synthesis of fatty acids. In a study conducted by Kozmus *et al.,* (2017) on two treatments, the first by adding 10% inulin and the second by adding 10% polyfructose to rats' diets for 7 weeks, both of which led to a significant reduction in serum cholesterol as well as abdominal fat and an increase in intestinal length compared to the control treatment. In a study conducted by Kim and Shin (2014) on rats, 0.2% cholesterol was added to the diets of the treatments containing 1% and 5% chicory extract, as well as the diet containing 5% inulin powder for 4 weeks, it was shown that the percentage of high-density lipoprotein (HDL) in the serum increased significantly, and the percentage of low-density lipoprotein (LDL) liver glycerides decreased significantly in the serum of the three treatments compared to the control. It also significantly increased the excretion of fat, cholesterol and bile salts in the feces of the treatments compared to the control. The effect of inulin on fat metabolism in humans differed according to the presence or absence of chronic diseases. In a study on diabetic patients that lasted for 14 days, with the intake of 8 g of polyfructose with a coffee drink, the cholesterol level was reduced by 19 mg/dl and low-density lipoproteins were significantly reduced by 17 mg/dl. In a study conducted by Causey *et al.,* (2014) on 12 males with high cholesterol, serum triglycerides were reduced by 40 mg/dl when 20 g of inulin from chicory extract was consumed, and serum cholesterol was reduced by 11 mg/dl and LDL was reduced. In a study of 21 male and female volunteers with high cholesterol, who consumed 18 grams of inulin daily with a low-fat diet for 4 weeks, there was a significant decrease in LDL by 4.4% and total cholesterol by 8.7%.

References

Brennan, C.S. and El-Nagar. G. F. (2001). The influence of fiber addition on the texture and quality of stirred yoghurt. Egyp. J. of Dairy sci.

Causey, J.L., Xin-Chua Y., Tungland, B.C., Feirtage, J.M., Gallaher, D.G. and Slavin J.L. (2014). Effect of dietary inulin on serum lipids, blood glucose and the gastrointestinal environment in hypercholestrolemic men. Nutr. Res., 20(2):191-201.

Chawla, R.and Patil, G. R. (2010). Soluble dietary fiber. Comprehensive Reviews in Food Science and Food Safety, 9: 178–196.

Cooper, P.Thymri ,T and Gemi ,S.(2016). Vaccine adjutants based on inulin in body . Pharm. Biotechnol. 8:439-467.

Gonzalez-Herrera,S.M. Herrera,R.R.,Lopez,M.G.,Rutiaga,O.M.,Aguilar, C.N., and Esquivel,J.C.(2015).Inulin in Food products :prebiotic and functional ingredient.British Food J.117:371-387.

Guggisberg, D.; Cuthberth-steven, J., Piccinali, P.; Bütikofer, U.and Eberhard,P.(2009).Rheological, microstructural and sensory characterization of low-fat and whole milk set yoghurt as influenced by inulin addition. Int Dairy J. 19:107-115.

Guven, M.; Yasar, K.;Karaca, O.;and Hayaloglu, A. A. (2005). The effect of inulin as a fat replacer on the quality of set-type low-fat yoghurt manufacture. Int.J.of Dairy Tech.58:180-184.

Hala,S.S.and Soha,R.K.(2017).Effect of chicory Inulin extract as a fat replacer on texture and sensory properties of cookies .Middle East J.of Applied Vol.07 Issue01:168-177.

Kaminskas, A.; Jonas, A.A.; Algirdas, L. ; Valerija, J.; Jūratė, V.; Loreta, B. ; Justė,A.; Vaiva, H.and Dalia, S.(2013). Quality of yoghurt enriched by inulin and its influence on human Metabolic syndrome.Veterinarija.

Kim, M. and Shin, H. K. (2014). The water-soluble extract of chicory influences serum & liver lipid concentrations, cecal short-chain fatty.

Kip, P.; Meyer, D. and Jellema, R. H. (2006). Inulins improve sensory and texture properties of low-fat yoghurts. Int.Dairy.J.16:1098-1103.

Kozmus,C.E.; Moura, E.; Serrao, MP, Real, H.; Guimarraes,J.T. and Guedes-de-Pinho,P.(2017). Influence of dietary supplementation with dextrin or oligofructose on the hepatic redox balance in rats.Mol.Nutr.Food Res.55(11):1735-9.

Maarten, A.; Henderik, W.; Kees, V.; and Wouter, L.(2015).Inulin ,a flexible oligosaccharide I:Review of its physicochemical characteristics. Carbohydrate Polymer 130(2015)405-419.

Meyer,D.; Bayarri,S.; Tarrega,A.and Costell,E.(2011).Inulin as texture modifier in dairy products.Food Hydrocolloids.25:1881-1890.

Mishra,S.,and Mishra,H.N.(2018). Comparative study of the symbiotic effect of inulin and fructooligosaccharide with probioticswith regard to the varius properties of fermented soy milk .Food science and technology international,24(7):564-575.

Mohammed, E.; Mahmoud,A.; Muhammad,A. and Kuldeep, D.(2017). Chicory (*Cichorium intybus*) herb:Chemical composition ,pharmacology,nutritional and healthical applications.Inter.J.of Pharmacology.ISSN1811-7775:1-10.

Moshfegh,A.J.; Friday, J.E.; Goldman, J.P. and Ahuja, J.K.(2016).Inulin and Oligofructose in the diets of Americans.J.Nutr.65:1398-1411.

Nicola, D.G.; Anne,D.and Gary,S.F.(2015). A randomized controlled trail :the effect of inulin on weight management and ectopic fat in subjects with prediabetes.J. Nutr.Metab.12:36:PP:33-42.

Olivera , R. P. D. S. ; Perego , P. ; De Oliveira , M. N., and Converti , A. (2011a). Effect of inulin as prebiotic and symbiotic interactions between probiotics to improve fermented milk firmness. J. Food . Engineering,107:36-40.

Rafter, J.; Bennett, M.; Caderni, G.; Clune, Y.; Hughes, R.; Karlsson, P.C.; Klinder, A.; O'Riordan, M.; O'Sullivan, G.C.; Zobel, B. P.; Rechkemmer.G.;Roller,M.; Rowland,I.; Salvadori,M.; Thijs,H.; Loo,J.V.;Watzl,B.,and Collins,J.K.(2007). Dietary synbiotics reduce cancer risk factors in polypectomized and colon cancer patients. Am. J. Clin. Nutr., 85(2): 488–496.

Rastal, R. A. (2017). Prebiotics and Probiotics Science and Techmnology. Springer Science +Business,LLC. 1-1397.

Saeed, M.; Mohamed,E. ; Abd, E . H. ; Alagawany , M.; Arain,M.A.; Arif,M.; Mirza,M.A; Naveed,M.; Chao,S.; Sarwar,M.; Sayab,M., and Dhama,K..(2017). Chicory (Cichorium intybus) Herb: Chemical Composition, Pharmacology, Nutritional and Healthical Applications. Inter.J.of Pharmacology,13 (4):351-360.

Schonewille, J. F.; Boer, D. and Mele ,L. (2016). Statins increase hepatic cholesterol synthesis and stimulate fecal cholesterol elimination in mice. J. of Lipid Research, vol. 57 no. 8 pp.1455–1464.

Shehzad, A.; Husnain,R.; Hafiz, R. and Azam, S.(2017). Inulin :Properties, Health benefits and food application. Carohydrate Polymer 147:444-454.

Sheng, W., Ji, G., & Zhang, L. (2023). *Immunomodulatory effects of inulin and its intestinal metabolites. Front Immunol 14: 1224092.*

Shoorideh, H.S.A.; Peighambari, M.; Omidi, M.R.; Naghavi, S. and Marou, F.(2016). Assessing Potential of Iranian Chicory Genotyps for Industrial Application. Int.J.Hort.Sci.Technol.3:59-68.

Stellaard, F. and Lütjohann,D.(2017). The Interpretation of Cholesterol Balance Derived Synthesis Data and Surrogate Noncholesterol Plasma Markers for Cholesterol Synthesis under Lipid Lowering Therapies.

Stellaard, F. and Lütjohann,D.(2017). The Interpretation of Cholesterol Balance Derived Synthesis Data and Surrogate Noncholesterol Plasma Markers for Cholesterol Synthesis under Lipid Lowering Therapies. Hindawi Cholesterol Volume 2017, Article ID 5046294, 9 pages.

Vandeputte, D.; Gwen, F.; Sara, V.; Jun, W.; Manuela, S.; Stephan, T.; Kristin, V. and Jeroen R.(2017).Prebiotic inulin –type fructans induce specific changes in the human gut microbiota.J.Food and Health.Doi:10.1136:1-7.

Wada, T.; Sugatani, J.; Terada, E.; Ohguchi, M. and Miwa, M. (2005). Physi-cochemical characterization and biological effects of inulin enzymaticallysynthesized from sucrose. Journal of Agricultural and Food Chemistry, 53, 1246–1253.

WHO. World Health Organization.(2016). Diet Nutrition and the Prevention of Chronic Diseases. World Health Organ Technical Report Series 797. WHO, Geneva, Switzerland.