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Diabetic jam prepared from beetroot enriched with flaxseed

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Abstract

This paper presents an endeavor to create vegetable jam using beetroot in combination with flaxseed. Flaxseed jam falls into the category of intermediate moisture products, which involves blending fruit pulp, sugar, pectin, acid, and other components to extend their shelf life. Addressing growing consumer health concerns, there is a current trend toward producing products like low-sugar and diabetic-friendly jams. Beetroot, distinguished by its natural deep reddish-purple hue, stands out as an excellent candidate for vegetable jam creation. This vibrant coloration primarily originates from betalain, an inherent pigment that also serves as an antioxidant and anti-inflammatory agent. Among various vegetables, beetroot exhibits the highest levels of antioxidant activity, boasting a rich array of phytochemicals such as ascorbic acid, carotenoids, flavonoids, and phenolic acid. Beetroot contains natural carbohydrates including sucrose, along with minor quantities of glucose and fructose. This composition finds utility in products like sports drinks, where the higher fructose content can limit exercise capacity. Given its low sugar content and potent nutrient profile, beetroot jam holds promise as a beneficial option for diabetic patients.

Keywords: Beetroot, flaxseed, betalain, antioxidant, jam

Introductions

In today's era, there is a significant demand for fruits and vegetables because they are abundant in vital dietary micronutrients and dietary fiber. Additionally, they have emerged as a crucial source of phytochemicals that could have potential benefits in preventing various lifestyle-related diseases such as cancer, heart disease, diabetes, and more. However, the seasonal and perishable nature of many fruits and vegetables limits their consumption. To address this issue, various preservation methods, including jam making, are employed. Typically, commercially available jams are high in sugar and may contain additives. In contrast, this particular jam stands out as an excellent choice for jam making. It boasts a natural deep reddish-purple color and is free from added sugars due to its inherent sugar content.

Jam is a product of intermediate moisture that is prepared using the pulp of fruits, sugar, pectin, acid, and other ingredients which lead to keep them for a long time. A good jam has a soft even consistency, without pieces of fruits, a bright colour, good flavor, and a semi-jelled structure that is easy to spread. The traditional jam market is mainly based on various kinds of fruit jam. Due to the increase of consumer health Concern, products such as low sugar and diabetic jam Have been introduced.

Beetroot stands out as an excellent choice for making vegetable jam due to its natural, vibrant reddish-purple hue. This intense red color primarily comes from its high betalin concentration, which serves as a natural food coloring agent in the food industry. Beyond its coloration properties, betalin also serves as a valuable antioxidant and anti-inflammatory agent.

Among vegetables, beetroot boasts the highest antioxidant activity and is a rich source of various phytochemicals, including ascorbic acid, carotenoids, flavonoids, and phenolic acid. In contrast to many fruits, beetroot's primary sugar component is sucrose, with only minimal amounts of glucose and fructose. This is particularly advantageous for products like sports drinks, as a high fructose content can reduce exercise capacity.

Moreover, beetroot juice is a treasure trove of health-promoting compounds, including potassium, magnesium, folic acid, iron, zinc, calcium, phosphorus, sodium, niacin, biotin,

B6, and soluble fiber. Its diverse biochemical content is associated with a range of therapeutic effects, such as anti-inflammatory and chemo preventive properties. Additionally, it aids in preventing DNA damage, reducing LDL cholesterol levels, increasing hemoglobin, decreasing total iron binding capacity, elevating ferritin levels, and reducing transferrin levels.

Flaxseed, also recognized as Linseed (*Linum usitatissimum* L.), stands as one of the world's oldest cultivated crops, still widely grown for its oil, fiber, and nutritional benefits. The seeds of the flax plant are rich in functional components like proteins, α -linolenic acid, lignans, mucilage, phenolic compounds, and small quantities of orbitides, all of which exhibit significant biological activity. Flaxseeds are gaining increasing popularity as dietary supplements due to their reported potential in enhancing human health and alleviating symptoms associated with a wide range of human ailments, including cardiovascular issues, diabetes, neural disorders, menopausal symptoms, skin conditions, gastrointestinal problems, and even cancer.

Furthermore, the proteins and cyclic peptides found in flaxseeds have been noted for their favorable properties, including antioxidant, antihypertensive, anti-inflammatory, immune-suppressive, and anti-diabetic attributes.

Nutritional composition of beetroot and Flaxseeds

Beetroot, scientifically known as *Beta vulgaris rubra*, is a significant plant-based ingredient that offers various proven health benefits to the human body. They can be enjoyed in multiple ways, including raw, steamed, boiled, or roasted. Red beetroot, in particular, is a treasure trove of essential minerals such as manganese, iron, sodium, potassium, magnesium, and copper. It also contains a wealth of antioxidants, vitamins (A, B, C), dietary fiber, and natural pigments. (Vasconcellos J, *et al.*, 2016)^[1]

The presence of phenolic compounds in red beetroot contributes to its antioxidant properties, making it a valuable dietary choice for safeguarding against heart disease and specific cancers, like colon cancer. Furthermore, beetroot is rich in other valuable compounds like carotenoids, glycine betaine, saponins, betacyanins, betaxanthins, folates, betanin, polyphenols, and flavonoids. Consequently, including beetroot in your diet may be considered a contributing factor in cancer prevention. Flaxseeds are rich in polyunsaturated fatty acids (PUFA) from the omega-3 family (Baião DS, Conte-Junior CA, *et al.*, 2016)^[2]. Specifically, they contain over 70% alpha-linolenic acid (ALA). Flaxseeds are a source of soluble dietary fiber in the form of mucilage. Flaxseeds are also abundant in lignans, with secoisolariciresinol diglucoside being a prominent type. These lignans exhibit phytoestrogen properties. The chemical composition of flaxseed exhibits significant variability based on different sources. On average, flaxseeds contain approximately 35-45% oil, consisting of around 9-10% saturated fatty acids (such as palmitic and stearic acids), roughly 20% monounsaturated fatty acids (predominantly oleic acid), and more than 70% alpha-linolenic fatty acids. Flaxseeds typically have a protein content ranging from 20-30%, with lysine being a limiting amino acid. In terms of B-group vitamins and certain minerals, flaxseeds are nutritionally similar to other crops (Al-Okbi SY, 2005)^[13]. Vitamin E in flaxseeds is primarily present in the form of gamma-tocopherol. Remarkably, flaxseeds are the richest plant-based source of lignans,

notably secoisolariciresinol diglucoside. This unique chemical makeup has led to extensive research into the preventive and functional properties of flaxseed. The presence of omega-3 PUFA, dietary fiber, and phytoestrogen lignans contributes to flaxseed's ability to lower cholesterol levels (hypolipidemic) and prevent artery plaque formation (antiatherogenic) (Dieken, H.A., 1992)^[16].

Beetroot is gaining recognition as a "superfood" owing to its remarkable health benefits. Some of the key advantages of consuming beetroot include: Blood Pressure Regulation and Improved Blood Circulation: Beetroot has been associated with lowering blood pressure and enhancing blood flow.

Healthier Weight and Reduced Risk of Diseases: Beetroot may contribute to tumor reduction, lower the risk of obesity, reduce overall mortality, and decrease the likelihood of heart disease and diabetes. It is also beneficial for promoting healthy hair, boosting energy levels, and aiding in weight management.

Numerous Medicinal Properties: Various components of beetroot offer medicinal properties, including antioxidant, antimicrobial, antihypertensive, hepato-protective (liver protection), anti-inflammatory, anti-hyperglycemic (blood sugar control), anti-cancer, and diuretic effects. Its high fiber content supports digestive health by preventing constipation and promoting regularity. Beetroot juice has shown promise in improving brain oxygenation, potentially slowing the progression of dementia in older adults.

Brain Function Preservation: Beetroot aids in preserving brain function by increasing blood flow, thanks to its nitrate content. Additionally, beetroot has the ability to naturally boost the production of Glutathione in the body, a compound known for its role in preventing colon cancer.

Gastric Ulcer Healing

Beetroot is gaining prominence as a "superfood" due to its remarkable health advantages. Here are some of the key benefits associated with beetroot consumption: Blood Pressure Control and Enhanced Circulation: Beetroot is known for its potential to lower blood pressure and improve blood circulation.

Promotes Healthy Weight and Reduces Disease Risk: Beetroot may aid in reducing the risk of obesity, lowering the likelihood of heart disease and diabetes, and even contributing to tumor reduction. It can also support weight management, boost energy levels, and promote healthy hair.

Diverse Medicinal Properties: Beetroot contains a range of medicinal properties, including antioxidants, antimicrobial agents, antihypertensive properties for liver protection (hepato-protective), anti-inflammatory effects, blood sugar regulation (anti-hyperglycemic), anti-cancer compounds, and diuretic properties. Its high fiber content promotes digestive health by preventing constipation and ensuring regularity. Additionally, beetroot juice has shown promise in enhancing brain oxygenation, potentially slowing the progression of dementia in older individuals.

Preservation of Brain Function: Beetroot helps maintain

brain function by increasing blood flow, thanks to its nitrate content. Moreover, beetroot naturally stimulates the production of Glutathione in the body, a compound known for its role in preventing colon cancer.

Healing Gastric Ulcers: Beetroot wine is beneficial for healing gastric ulcers. It is also rich in potassium, which increases urine output and aids in managing low blood sugar levels (hypoglycemia). Beetroot has been employed in the treatment of various conditions, including jaundice, hepatitis, nausea, vomiting associated with biliousness, tuberculosis, piles, cholera, diarrhea, dysentery, and recovery after major surgery when the body's resistance is compromised. The cellulose content in beetroot acts as a bulk residue, facilitating healthy bowel movements and contributing to hypertension management.

The Insoluble fiber in flax seed adds bulk to the stool, preventing constipation. Studies have also shown that fiber-rich foods help food waste travel through the colon more quickly. When waste stays in the intestine too long, some of the toxins can be reabsorbed into the body. Slow transit of food through the intestine can lead to conditions like diverticulitis and colon cancer. A meta-analysis of 28 studies showed that adding flax seed to the diet lowers total cholesterol and LDL cholesterol, the "bad" cholesterol. The results varied according to the parameters of the studies, but animal studies had already shown similar effects. The studies used flax seed or lignans derived from flax seed.

The ALA in flax seed may be effective in improving cardiovascular health and reducing the risk of stroke. This positive effect has appeared in both animal studies and observational studies of humans. A small amount of flax seed is sufficient to improve health, and adding it to the diet has no major negative effects.

When people with diabetes add flaxseed to their diets, their blood glucose levels improve, several studies have shown. Researchers believe the improvement is due to the combination of fiber, omega-3s, and lignans in the flax seed. Flax seeds contain insoluble fiber that increases stool bulk, preventing constipation. Research also indicates that fiber-rich foods facilitate the efficient movement of food waste through the colon. Prolonged waste retention in the intestine can potentially result in the reabsorption of toxins, leading to conditions like diverticulitis and colon cancer.

A comprehensive analysis of 28 studies revealed that incorporating flax seeds into the diet can lower both total cholesterol and LDL cholesterol, often referred to as "bad" cholesterol. The specific outcomes varied based on the study parameters, but similar effects had already been demonstrated in animal studies. These studies utilized either flax seeds or lignans extracted from flax seeds.

The presence of ALA (alpha-linolenic acid) in flax seeds may have a positive impact on cardiovascular health and reduce the risk of stroke. This beneficial effect has been observed in both animal experiments and observational studies involving humans. Even a small amount of flax seeds can lead to health improvements, with no significant adverse effects when added to the diet.

Several studies have shown that the inclusion of flaxseed in the diets of individuals with diabetes leads to improved blood glucose levels. Researchers attribute this improvement to the combined benefits of fiber, omega-3 fatty acids, and lignans found in flax seeds. (Dieken, H.A.,

1992) ^[16] (Du H, 2010) ^[17].

Discussion

Jam is a product with intermediate moisture content made from fruit pulp, sugar, pectin, acid, and other ingredients to extend its shelf life. A high-quality jam should have a smooth, consistent texture without fruit pieces, vibrant color, rich flavor, and a semi-gelled structure that spreads easily. Beetroot stands out as an excellent vegetable choice for making jam due to its natural deep reddish-purple hue. Two methods were used to create beetroot jam, one involving mild processing and the other involving cooking. Sensory analysis revealed that the jam made using the mild method, consisting of 60% raw beetroot pulp and flaxseed powder, was the preferred choice. This developed jam was stored in a refrigerator for six months without the need for any artificial preservatives. The research indicates that the jam produced using boiled beetroot water and flaxseeds has lower sugar content and higher nutrient levels compared to typical products of this kind. This jam is fullfil various types of deficiencies and combat many disease. (Diego dos S Baião, Davi VT, *et al.*, 2017) ^[2].

Beetroot offers a wide range of health benefits, including Lowering blood pressure and enhancing blood flow, Contributing to tumor reduction and reducing the risk of obesity, overall mortality, heart disease, and diabetes, promoting healthy hair, increasing energy levels, and aiding in weight management, possessing various medicinal properties such as antioxidant, antimicrobial, antihypertensive, hepato-protective (liver protection), anti-inflammatory, antihyperglycemic (blood sugar control), anti-cancer, and diuretic effects. Preventing constipation and promoting regularity in the digestive tract due to its high fiber content, enhancing brain oxygenation, potentially slowing the progression of dementia in older individuals. Preserving brain function by improving blood flow through its nitrates and boosting the natural production of glutathione in the body, which plays a role in preventing colon cancer.

Aiding in the healing of gastric ulcers and increasing urinary output thanks to its potassium content. Being beneficial in the treatment of various conditions such as jaundice, hepatitis, nausea, vomiting related to biliousness, tuberculosis, piles, cholera, diarrhea, dysentery, and aiding post-surgical recovery in weakened individuals. The cellulose in beetroot acts as bulk residue, promoting healthy bowel movements and potentially reducing blood pressure in hypertensive individuals.

Flax seeds contain insoluble fiber, which contributes to stool bulk and helps prevent constipation. Additionally, research indicates that foods rich in fiber facilitate the rapid movement of food waste through the colon. Prolonged retention of waste in the intestines can result in the reabsorption of toxins into the body, potentially leading to conditions like diverticulitis and colon cancer. The presence of ALA (alpha-linolenic acid) in flax seeds may effectively enhance cardiovascular health and reduce the risk of stroke. This positive effect has been observed in both animal experiments and observational studies involving humans. Even a small quantity of flax seeds can have health benefits, and their inclusion in the diet generally has no significant adverse effects.

Several studies have demonstrated that individuals with diabetes experience improved blood glucose levels when

they incorporate flaxseed into their diets. Researchers attribute this improvement to the combination of fiber, omega-3 fatty acids, and lignans found in flax seeds.

Jam Ingredients

Beetroot and Flaxseeds jam is not only blessed with a beautiful color but also full of nutrients. A detailed view of these nutrients comes out to be like:

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Beetroot jam enriched with flaxseed is not only blessed with a beautiful color but also full of nutrients. Beetroots are a good source of folic acid and Vitamin C. It also contains small amounts of vitamins B₁, B₂, B₃, and vitamin A in the form of betacarotene. Flaxseed is a good source of vitamin A and E. It also contains niacin, vitamin B₁ and B₂ rich in calcium, magnesium, phosphorus, Potassium, and sodium. Also, smaller amounts of iron, Copper, zinc, manganese, and selenium. While raw beets are mostly contain water and carbohydrate, they also contain small amounts of all the amino acids (protein). Its carotenoids and flavonoids can help reduce the oxidation of LDL cholesterol which could lead to damaged artery walls and ultimately heart attacks and strokes. It also contains phenols. The deep red color of beetroot comes from betacyanin. This prevents from Colon cancer. The rich stock of silica in it does perfect utilization of calcium in the body and is also required for healthy skin, hair, nails and bones. Beetroot and flaxseed jam not only boasts a vibrant color but also offers a wealth of nutrients. A closer look at these nutrients reveals the following. Beetroots are a good source of folic acid and Vitamin C. They also contain modest amounts of vitamins B₁, B₂, B₃, and vitamin A in the form of beta-carotene. Flaxseeds provide vitamin A and E and also contain niacin, vitamin B₁, and B₂. Both beetroot and flaxseeds are rich in minerals, including calcium, magnesium, phosphorus, potassium, and sodium. They also contain smaller amounts of iron, copper, zinc, manganese, and selenium. While raw beets are primarily composed of water and carbohydrates, they do contain small amounts of all the essential amino acids, which contribute to their protein content. The presence of carotenoids and flavonoids in beetroot can help reduce the oxidation of LDL cholesterol, potentially preventing damage to artery walls and reducing the risk of heart attacks and strokes. Beetroot also contains phenols, which have antioxidant properties. The deep red color of beetroot is attributed to betacyanin, a compound that may have

protective effects against colon cancer. Beetroot is rich in silica, which aids in the efficient utilization of calcium in the body. Silica is also essential for maintaining healthy skin, hair, nails, and bones.

Flax seeds contain insoluble fiber, which contributes to stool bulk and helps prevent constipation. Additionally, research indicates that foods rich in fiber facilitate the rapid movement of food waste through the colon. Prolonged retention of waste in the intestines can result in the reabsorption of toxins into the body, potentially leading to conditions like diverticulitis and colon cancer.

The presence of ALA (alpha-linolenic acid) in flax seeds may effectively enhance cardiovascular health and reduce the risk of stroke. This positive effect has been observed in both animal experiments and observational studies involving humans. Even a small quantity of flax seeds can have health benefits, and their inclusion in the diet generally has no significant adverse effects. Several studies have demonstrated that individuals with diabetes experience improved blood glucose levels when they incorporate flaxseed into their diets. Researchers attribute this improvement to the combination of fiber, omega-3 fatty acids, and lignans found in flax seeds.

Conclusion

Beetroot and Flaxseeds is a superfood used as therapeutic and functional food ingredients from ancient times. This review paper concludes the all scope of beetroot and flaxseeds and their utilization as value added products. It has various applications as a food coloring ingredient in many dairy and food products. It has number of medicinal properties such as antioxidant, anti-microbial, anti-hypertensive, anti-inflammatory, antihyperglycemic, hepato-protective, anti-cancer, chemo prevent activity etc. It also prevents DNA damage and reduces LDL level. Beetroot increases hemoglobin, decrease in total iron binding capacity, increase ferritin and decrease transferrin. Flaxseed dietary fibre (lignin) exhibits positive effect to reduce constipation and reduce cholesterol. It is a multipurpose crop having numerous health benefits providing scientists a new door to develop various value added products.

Future Scope

This study seeks to promote the incorporation of beetroot jam enriched with flaxseed showing health benefits associated with alleviating constipation and reducing cholesterol levels. The combination of these two valuable ingredients offers a multitude of health benefits, opening up new avenues for scientists to develop a wide range of value-added products. Such research can be valuable in promoting healthier dietary choices and potentially reducing the risk of heart-related issues. We wish its extensive adoption in the food industry, food processing, food formulation, and the advancement of innovative food products in the upcoming years.

Conflict of Interest

There is no conflict of interest between the authors in publication of this paper.

Author's Contribution

Sritama Banerjee undertook the entire literature review. Dr. Rupali Dhara Mitra conceptualized the idea and title of this

paper and also provided comprehensive editing for the entire manuscript.

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