About the Book

Applied Clinical Nutrition and Food Science: A Holistic Guide towards Robust Health" offers a comprehensive exploration of the intersection between nutrition science and practical health applications. It delves into the fundamental principles of macronutrients and micronutrients, the latest advancements in food science, and evidence-based dietary strategies for managing chronic diseases. The book emphasizes a holistic approach, integrating traditional dietary practices with contemporary research to address the cultural and lifestyle factors that influence health. With contributions from leading experts, this guide serves as an invaluable resource for healthcare professionals, nutritionists, students, and anyone committed to improving their health through informed and balanced nutrition choices.

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Applied Clinical Nutrition and Food Science: A Holistic Guide towards Robust Health

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Applied
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A Holistic Guide towards Robust Health

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Applied Clinical Nutrition and Food Science: A Holistic Guide towards Robust Health

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Preface

In today's fast-paced world, where convenience often trumps nutritional value, the importance of a well-rounded and science-based approach to nutrition and food science cannot be overstated. "Applied Clinical Nutrition and Food Science: A Holistic Guide towards Robust Health" aims to bridge the gap between scientific research and practical application, providing readers with the knowledge and tools needed to make informed decisions about their health and wellness.

This book is the culmination of extensive research and clinical experience, offering a comprehensive guide that addresses the multifaceted nature of nutrition and its impact on human health. It delves into the biochemical and physiological aspects of nutrients, exploring their roles in maintaining and improving bodily functions. Moreover, it emphasizes the significance of a balanced diet, personalized nutrition plans, and the integration of traditional and contemporary dietary practices. Our approach is holistic, recognizing that optimal health is not just about individual nutrients but also about the synergy between different components of the diet and lifestyle. We examine the latest advancements in food science, including functional foods, nutraceuticals, and the role of the microbiome, to provide a well-rounded perspective on how diet influences health outcomes.

Dr. Souvik Tewari

Dr. Manisha Maity

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Chapter - 1
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Chapter - 1

Enrichment of Biscuits with Omega-3 Fatty Acids: A Review

Anushree Kul and Manisha Maity

Abstract

Various foods are essential sources of omega-3 fatty acids, which are also an important form of fat, specifically polyunsaturated fatty acids. Omega 3, which is also known as essential fatty acids. The types of omega 3 polyunsaturated fatty acids, such as docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) play a major role in brain growth and development. It has many potential health benefits, such as helping to lower triglyceride levels, increase good cholesterol, and decrease blood pressure.

Unconventional making and baking conditions were sucked for obtaining omega-3 polyunsaturated fatty acid enriched biscuits. The aim of this current review article is to know about the health beneficial effects of biscuits formed from a mixture of omega 3 fatty acids rich plant products. These biscuits can be included in our regular diet to fight against several diseases and maintain sound health.

Keywords: Omega-3 fatty acids, food products, health benefits, biscuits.

Introduction

Omega-3 (ω-3) fatty acids are organic compounds structured through a hydrocarbon chain with a carboxylic group that is generally bound to form acylglycerides (Rubio-Rodriguez *et al.*, 2010). In naturally occurring fatty acids, they can be distinguished into 3 types based on the bunch of double bonds present in the side chain: saturated fatty acids, monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) (Saini *et al.*, 2018; Cholewski *et al.*, 2018). The very high amount of docosahexanoic acid (DHA) in the mammals' brains coupled with the remarkable formation of the fatty acid has recommended that this acid may play a major role in brain functioning (Fedorova *et al.*, 2006).

Because of their affordable price and lengthy shelf life, biscuits are a

highly popular ready-to-eat item (Pasqualon *et al.*, 2021). The main components needed to make biscuits are sugar, butter, or oil, and wheat flour. These ingredients also provide dense calories, saturated fat, low fibre, and mineral contents. They also give biscuits their flavor, taste, texture, and general acceptability (Umesha *et al.*, 2015). The primary component that significantly influences the final product quality in the biscuit sector is sucrose, or sugar (Gupta *et al.*, 2017). For encapsulation, maltodextrin and fish gelatin were utilized as wall materials. Fish oil was used in three different ways to make the cookies: fish oil microencapsulate, fish oil-in-water emulsion, and fish oil (Jeyakumari *et al.*, 2016).

The most popular bakery goods in Egypt are biscuits, which are consumed by nearly every segment of the population, and some factors contributing to their widespread popularity include their lower cost when compared to other manufactured foods, their excellent nutritional value and accessibility in a variety of forms, their varied taste and longer shelf life, and the fact that bakery goods can be used to incorporate a variety of nutritionally rich ingredients (El-Hadidy *et al.*, 2018). ω-3 fatty acids (long chain) may help with neurogenerative illness, cardiovascular disorders, childhood behavior and learning, inflammatory bowel syndrome, as well as rheumatoid arthritis (Calder *et al.*, 2009). The goal of efforts to enhance the nutritional qualities of biscuits was to lower their fat, sugar, and energy content (Pasqualone *et al.*, 2013).

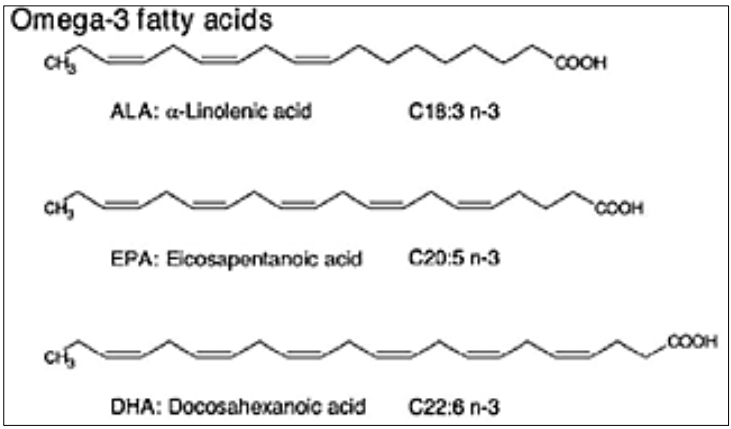

Fig 1: Examples of omega 3 fatty acids

Sources of ω-3 fatty acids

One of the important dietary fats are ω-3 fatty acids, particularly DHA and EPA, that are associated with anti-inflammatory processes in our body as

well as maintaining cell membrane functionality (Swanson *et al.*, 2012). Consequently, it is widely acknowledged that EPA and DHA are necessary for a healthy, balanced diet, that they have positive effects on development, particularly in the neurological system, and that they can help to mitigate a variety of pathological diseases (Tocher *et al.*, 2019).

Since DHA, DPA, and EPA are present in fish and various seafood in large amounts, they can be referred to as marine ω-3 fatty acids. Lesser intake of marine fish (< 0.2 g/day) than regular fish containing lean flesh reduces the consumption of omega 3 fatty acids, which leads to the occurrence of several disorders and poor psychomotor development. The livers of some fish like cod fish, are good reservoirs of ω-3 fatty acids (Calder *et al.*, 2015). As a result, consuming these marine omega 3 fatty acids is crucial for maintaining a healthy lifestyle, which could be difficult for vegans and vegetarians who don't consume much in the way of food (Lane *et al.*, 2022).

Health benefits

The known health benefits of PUFAs, including eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and α-linolenic acid (ALA), include their neurodevelopmental, cardio-protective and anti-inflammatory qualities (Umesha *et al.*, 2015). To summarize, the protective effects of ω-3 lipids have been linked to modifications in eicosanoid synthesis, decreased risk of cardiac arrhythmia-related sudden death, enhanced protection against myocardial ischemia, enhanced myocardial function, and decreased risk of other cardiovascular and autoimmune diseases (Fernandes *et al.*, 1993). The ω-3 fatty acids play significant roles in human health and illness, and they enhance visual growth and learning in infancy as well as cognitive development. Once more, studies have shown that long-chain EPA and DHA can help prevent depression and suicide, as well as postpone the onset of aging-related brain degeneration (Deckelbaum *et al.*, 2012). Consuming fish oil reduces the generation of tumor necrosis factor-alpha (TNFα) in healthy individuals and increases body weight in those with severe heart failure (Tur *et al.*, 2012).

Conclusion

In conclusion, formulating ω-3 fatty acid-rich biscuits can be a promising approach to enhancing the nutritional value of a popular snack. The incorporation of ingredients like fish oil, flaxseeds, or algae can provide health benefits associated with omega-3s. However, it is essential to maintain taste, texture, and shelf stability during the formulation process. Regular consumption should be part of a balanced diet, and consumers should be aware of the overall nutritional content, including any added sugars or additives in

these biscuits.

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Chapter - 2
Indian Traditional Fermented Foods and their Nutrition and Nutraceutical Potential: An Overview

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Chapter - 2

Indian Traditional Fermented Foods and their Nutrition and Nutraceutical Potential: An Overview

Priyanka Roy and Souvik Tewari

Abstract

Traditional Indian fermented foods offer a unique combination of taste, nutrition, and health benefits. These foods not only play a significant role in the diet but also offer numerous health benefits due to their nutritional and nutraceutical properties. This chapter provides an overview of some of the most popular traditional Indian fermentation foods, their preparation methods, nutritional content, and their potential health benefits.

Keywords: Indian fermented foods, gut health, dahi, idli, traditional foods

Introduction

India has a long history of fermented foods, which have been a staple of the country's cuisine for many years (Ananthanarayan *et al.*, 2019). These foods not only play a significant role in the diet but also offer numerous health benefits due to their nutritional and nutraceutical properties (Das *et al.*, 2012).

Traditional fermented dishes from India, such kanji, dhokla, dosa, and idli, are essential to the nation's rich culinary history (Roopashri *et al.*, 2023). These meals are high in probiotics, which increase the number of good bacteria in the digestive system and hence improve gut health (Leeuwendaal *et al.*, 2022). Nutrients become more bioavailable through fermentation, which facilitates easier absorption (Adebo *et al.*, 2022). For example, fermented rice and urad dal, used to make idli and dosa, are excellent sources of proteins, vitamins, and minerals. Similar to this, dhokla, a steaming fermented snack made from chickpea flour, boosts immunity and aids in digestion in addition to being nutrient-dense (Salis *et al.*, 2021).

Black carrot-based fermented rice drinks, such as kanji, are well-known for their cooling effects and capacity to improve general health (Rasika *et al.*, 2021). A healthy immune system and general wellbeing depend on a balanced gut flora, which is something that these foods help to maintain (Bengmark, 2013).

This chapter provides an overview of some of the most popular traditional Indian fermented foods, their preparation methods, nutritional content, and their potential health benefits.

Table 1: Indian traditional fermented food along with their health benefits

Fermented Food	Region	Health Benefits
Dahi	All over India	Probiotics improve gut health, boost immunity, aid digestion, and help reduce lactose intolerance symptoms (Oak and Jha, 2019).
Idli	South India	High in protein and carbohydrates, increases bioavailability of vitamins, easy to digest (Karaś *et al.*, 2017).
Dosa	South India	Rich in protein and carbohydrates, improves nutrient absorption, promotes digestive health (Ma *et al.*, 2017).
Dhokla	West India	Good source of protein and fibre, low in calories, enhances mineral absorption (Hanif *et al.*, 2006).
Kanji	North India	Rich in probiotics, vitamins, and antioxidants, aids detoxification, improves digestion, boosts immunity (Ashaolu, 2020).
Gundruk	Northeast India	High in fibre, vitamins, and minerals, enhances nutrient bioavailability, supports gut health (Yang *et al.*, 2020).
Achar (Pickles)	All over India	Rich in vitamins, minerals, and antioxidants, contains probiotics, may help control blood sugar levels (Behera *et al.*, 2020s).
Bhaati Jaanr	Northeast India	Probiotics improve gut health, provide energy, enhance nutrient absorption (Jaiswal *et al.*, 2023).
Handvo	West India	Good source of protein and fibre, promotes digestive health, low in calories (Salis *et al.*, 2021).
Batter for Pesarattu	South India	High in protein, improves digestion, rich in essential vitamins and minerals (Palika *et al.*, 2020).

Traditional Indian Fermented Foods

1. Dahi (Curd/Yogurt)

Dahi, a staple in Indian households, is a fermented milk product prepared by adding a bacterial starter culture to milk (Mallappa *et al.*, 2021). The bacteria, primarily *Lactobacillus* species, ferment the lactose in milk, producing lactic acid, which coagulates the milk proteins and imparts a tangy flavor (Penna *et al.*, 2015).

Nutritional and Health Benefits

- Rich in protein, calcium, and B vitamins.

- Probiotics in dahi improve gut health, boost immunity, and aid in digestion.
- May help in reducing lactose intolerance symptoms (Mudgal and Prajapati, 2017).

2. Idli and Dosa

Idli and dosa are popular breakfast items in South India, made from fermented batter of rice and black gram (urad dal). The fermentation process, carried out by naturally occurring lactic acid bacteria and yeast, enhances the nutritional profile of the batter (Sarkar *et al.*, 2015).

Nutritional and Health Benefits:

- High in carbohydrates and protein.
- Fermentation increases the bioavailability of vitamins, particularly B vitamins.
- Easy to digest due to the breakdown of complex carbohydrates during fermentation (Ramalingam *et al.*, 2019).

3. Dhokla

Dhokla is a steamed cake made from a fermented batter of rice and chickpea (besan). The batter is fermented using lactic acid bacteria, which enhance the nutritional content and make it fluffy and spongy (Padmashree *et al.*, 2023).

Nutritional and Health Benefits

- Good source of protein and fibre.
- Low in calories, making it a healthy snack option.
- Fermentation reduces antinutritional factors like phytic acid, enhancing mineral absorption (Singh and Mishra, 2020).

4. Kanji

Kanji is a traditional fermented drink made from black carrots, mustard seeds, and water (Bali *et al.*, 2024). The fermentation is carried out by naturally occurring lactic acid bacteria, which give it a distinctive tangy flavor (Hu *et al.*, 2022).

Nutritional and Health Benefits

- Rich in probiotics, vitamins, and antioxidants.
- Helps in detoxification and improving digestion.

- Potential to boost immunity and reduce inflammation (Bali *et al.*, 2024).

5. Gundruk

Gundruk is a fermented leafy green vegetable product popular in the northeastern states of India (Sathe and Mandal, 2016). It is prepared by fermenting leafy greens like mustard, radish, or cauliflower leaves, which are sun-dried and then fermented (Wacher *et al.*, 2010).

Nutritional and Health Benefits:

- High in fibre, vitamins, and minerals.
- Fermentation enhances the bioavailability of nutrients.
- Contains probiotics that improve gut health (Anal *et al.*, 2023).

6. Achar (Pickles)

Indian pickles, or achar, are made by fermenting vegetables and fruits with a mixture of spices, salt, and oil (Chakraborty and Roy, 2018). The fermentation is facilitated by lactic acid bacteria, which preserve the food and enhance its flavor (Montet *et al.*, 2014).

Nutritional and Health Benefits:

- Rich in vitamins, minerals, and antioxidants.
- Probiotics in pickles support digestive health.
- May help in controlling blood sugar levels (Chakraborty and Roy, 2018).

Nutritional and Nutraceutical Potential of Indian Fermented Foods

The nutritional and nutraceutical potential of traditional Indian fermented foods is significant due to the following reasons (Das *et al.*, 2016):

1. Enhanced nutritional profile

- Fermentation improves the bioavailability of vitamins and minerals (Adebo *et al.*, 2022).
- It reduces antinutritional factors like phytic acid and tannins.

2. Probiotic benefits

- Fermented foods are rich in beneficial bacteria that support gut health.
- Probiotics boost immunity, improve digestion, and may help in managing gastrointestinal disorders.

3. **Antioxidant properties**

- Many fermented foods contain antioxidants that help in neutralizing harmful free radicals (Ifeanyi, 2018).
- Antioxidants play a role in reducing inflammation and preventing chronic diseases (Zhang *et al.*, 2015).

4. **Potential therapeutic effects**

- Regular consumption of fermented foods may help in managing conditions like lactose intolerance, irritable bowel syndrome, and certain allergies (Morcos *et al.*, 2009).
- Fermented foods have been linked to improved mental health due to the gut-brain axis connection (Balasubramanian *et al.*, 2024).s

Conclusion

Indian traditional fermented foods offer a unique combination of taste, nutrition, and health benefits. Their preparation methods, deeply rooted in culture and tradition, not only preserve food but also enhance its nutritional value. With their rich probiotic content and numerous health benefits, these foods hold significant potential in promoting overall well-being. As modern science continues to uncover the health benefits of fermented foods, there is a growing appreciation for these ancient culinary practices that contribute to a healthy and balanced diet.

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Chapter - 3
A Review Paper on Impact on Nutrition Education among Student

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Chapter - 3

A Review Paper on Impact on Nutrition Education among Student

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Abstract

Nutrition education is the main key to prevent health diseases. Promoting healthy lives and preventing any type of chronic diseases are controlled in large part by nutrition education. The importance and effects of nutrition education are examined in this abstract in a variety of settings. Specializing in dietary guidelines, practical cooking skills, and behavior modification tactics, effective nutrition education incorporates a variety of approaches catered to different demographics. Its focus areas include healthcare institutions, businesses, communities, and schools. Its objective is to enhance individuals' understanding, perspectives, and actions around food selection and eating habits. People are better equipped to make educated food choices when they have a deeper grasp of the role that nutrition plays in general health and well-being. Furthermore, studies on nutrition education interventions have shown promise in improving long-term health outcomes and lowering the prevalence of diet-related disorders. Therefore, it is crucial to give nutrition education campaigns top priority.

Keywords: Nutrition education, chronic diseases, dietary guidelines, behavior modification, healthcare institutions

Introduction

As everyone is aware, diet plays a critical role in our lives. Nutrition is the study of food science. It can be defined as food at work throughout the body. Nutrition is the process of ingesting food and using it to produce energy and other essential nutrients needed to survive (Gupta, 2014). On the other hand nutrition education is a crucial stage of life-alternating shifts from childhood to maturity. In order to maintain good eating habits and make the proper food choices, an individual must posses adequate nutritional knowledge. Appropriate nutrition education provides information about nutrition and nutrition education programs directly influence people’s

understanding and behavior around nutrition. There is dietary information available (Yolcuoglu and Kiziltan, 2021). The primary goal of nutrition education is to provide knowledge about the relationship between nutrition and health and the appropriate foods to eat. Improves maternal health, a stronger immune system, a decrease risk of non-communicable diseases, etc. are all linked to nutritional education. It is possible to integrate nutritional education into a school's curriculum at different points during the day. Nutritionist today point out that in environmental and food, but also human health. It is said that healthy diets will promote health by encouraging more ecologically friendly eating habits. The kind and quantity of food consumed has an impact on the environment. According to studies, eating quality has no clear correlation with an individual's development in the areas of culture, economy or education. A person's nutritional state is correlated with their health-related quality of life which is further linked to an unhealthy lifestyle. Although nutrition education is frequently utilized to provide healthy eating habits and nutrition knowledge to a variety of population groups, it is still frequently employed with students. According to all of these correlation, its critical to develop healthy eating habits early in life. The purpose of this reviews is to describe how various nutrition education initiatives affects students eating habits. (Besler *et al.*, 2015)

Effects on nutrition

Education on nutrition has a vital role in safeguarding and enhancing health. Nutrition education's effects on learning, growth, and development. Programs for nutrition education are a useful tool for assisting kids and teenagers in developing a healthy diet. Instructors must participate in school-based nutrition education initiatives (Mukhamedzhanou *et al.*, 2023). Teachers' morale and physical health have improved as a result of the training, raising the standard of instruction. One of the variables influencing dietary preferences, lifestyle decisions, and the nutritional well-being of individuals, families, and communities is the degree of nutritional education. It has been demonstrated that, across several nations, adolescent nutrition education improves adolescents' attitudes, practices, and understanding of healthy eating. The HB level of teenagers and nutritional status were greatly enhanced by the nutrition education initiatives (Addullah, 2021). Impact on nutrition can differ significantly based on lifestyle, diet, health, and food availability, among others factors. Typically impacts on nutrition include the following:

1) **Malnutrition:** Inadequate consumption of vital nutrients, resulting in imbalances or deficiencies that can impaired immunity, cause growth retardation, and cause other health issue.

2) **Obesity:** Consumption of food high in calories but low in nutrients can result in obesity, which rises the risk of developing chronic illness include diabetes, heart disease and some types of cancer.
3) **Micronutrients deficiencies:** Inadequate consumption of vitamins and minerals can result in deficiencies which can cause a variety of health problems such as immune system dysfunction anaemia and visual impairment.

Deficits in some nutrients especially those related to vitamins minerals and essential fatty acids can lead to poor cognitive function which can impact memory focus and general (Mukhamedzhanou *et al.*, 2023).

Role of nutrition education

The purpose of nutrition education is to modify unhealthy habits by reinforcing certain nutrition-related behaviours or components. To promote and safeguard healthy health by establishing wholesome eating and nutrition habits. Nutrition education emphasizes the importance of quick diagnosis and treatment of malnourished individuals and those at risk for malnutrition, while also offering doable solutions. Nutrition education identifies attitudes toward and perceptions of food and nutrition among students and teachers, as well as providing encouragement for children and adolescents to eat healthily (Rodrigo and Aranceta, 2001). Along with the dissemination of nutrition knowledge, nutrition education also focuses on the development of behaviours and skills in areas like food preservation and storage, eating in relation to social and cultural contexts, improved self-esteem and positive areas. A small but steady improvement in teenage understanding and decision-making can be achieved by a combination of community-wide health promotion initiatives and several intervention components, such as behavioural education in schools.

Here are some key in role of nutrition education:

1) **Increasing awareness:** Nutrition education helps people comprehend the connection between diet and health outcomes and brings attention to the significant of a balance diet.
2) **Increasing knowledge:** It offers details on food values, portion size, dietary recommendation and the significant of nutrients of good health.
3) **Changing behaviour:** Nutrition education enables people to acquired useful abilities and methods for selecting healthier foods, such as meal planning, reading food labels and preparing wholesome meals at home.

4) **Preventing malnutrition:** Nutrition education helps prevent deficiencies and promotes adequate nutrients intake across all age groups by educating individuals about the symptoms and effects of malnutrition.
5) **Managing Chronic Illness:** Nutrition education offers support to people with long term problems including diabetes, heart disease or obesity (Lee, S.U. *et al.*, 2006)

Methods of conducting nutrition education

The following describe the nutrition education strategies and the channels of communication they use:

1) **Films shows and slides shows:** These are very successful forms of instruction. They should be easily understood, useful, and illustrative.
2) **Pictures, charts and exposition**: Image should be straightforward, grab the viewers attention right away and be written in the local tongue. At a distance, the lettering should also be easy and plainly visible. Additionally, charts must to be able to pique people's curiosity. The graphic must not be overly cluttered and must be properly balanced with the usage of the right colours. The most effective way to educate the public is through exhibits with charts and illustrations. The educational program should be designed with the participants educational background in mind.
3) **Books, bulletins and newspaper articles**: Education professional such as teachers and students can benefit from printed materials on nutrition. These resources must to be made available in the local tongues and provide adequate details.
4) **Radio and television:** Programs on radio and television quickly reach a big audience. Comedy, drama, tales etc. bringing up the dietary issue aids in raising public awareness.
5) **One-on-one counselling:** Offering each person individualized advice and support according to their unique nutritional needs and objective.
6) **Programs for continuing education:** These provides healthcare workers, teachers and community leaders with training secession and workshop to improve their knowledge and abilities in nutrition counselling and education.

Incidence

From 2009 to 2016, the authors examined 41 published studies on child nutrition education interventions. The majority of studies, which mostly targeted primary school students, were carried out outside of the United States. While several studies were only partially effective and some did not reach their aims, about half of the investigations achieved their principal study goals. Although theory influenced several of the research, there was no discernible benefit to applying theory to these therapies. Both manual and database searches turned up 8,619 articles, of which 224 were subjected to full text review. Sixty-seven85 publications were eliminated by the researchers because they did not meet certain criteria, such as not being pertinent to the research, not concentrating on adolescent populations in industrialized nations, not utilizing several strategies for nutrition education, or not providing adequate data. Educational institutions around Europe and the USA are putting policies in place to encourage youth physical exercise and a healthy diet. The significant of health education in schools is emphasized by programs such as the EURODIET initiative and guidelines issued by agencies such as the centre for diseases control and prevention. The creation of curricula, teacher preparation and supporting surroundings are among the initiatives. Notwithstanding the advancements further study is required to enhance application and win over the community.

Conclusion

In summary, the program's nutrition instruction and assessment may provide a discernible gain in knowledge about nutrition, but less of an improvement in attitudes and behavioural intentions connected to nutrition. A long-term extension of the initiative may result in even greater progress. It is possible that nutrition education will encourage future generations to have healthier lifestyles. In addition to improving physical health and lowering illness susceptibility, research has shown that a healthy di*et al*so supports scholastic achievement and cognitive growth. For nutrition education initiatives to be as effectives as possible, it is critical to use both creative and evidence- based techniques. These results support this point. Nutrition education plays an important role in promoting general health and well- being among the student population by equipping them with the knowledge and skills necessary to make informed dietary choices. The increasing incidence of diet- related illnesses must be addressed going ahead and school environments must foster a culture of health and wellness through sustained research and funding for nutrition education programs. Despite the fact that some studies were only partially successful, there was no obvious benefits to

using theory in these interventions. Through manual and database searchers, the researchers found 8,619 publications, of which 224 were subjected to full text review. In the end, 67 papers were excluded based on a number of factors, including not being pertinent to the study or not offering enough information.

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Chapter - 4
Dragon Fruit Diversification: A Detailed Review on Variations and Nutritional Profiles

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Chapter - 4

Dragon Fruit Diversification: A Detailed Review on Variations and Nutritional Profiles

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Abstract

This thorough analysis offers an in-depth investigation of the varied realm of dragon fruit, showcasing different kinds and their distinct nutritional characteristics. Dragon fruit, sometimes called pitaya or pitahaya, is becoming more and more well-known around the world due to its eye-catching colour and possible health advantages. The goal of this study is to remark a thorough conception of the unique features and nutrient contents of several dragon fruit variants. The first section of the review introduces the two main varieties of a dragon fruit: Hylocereus polyrhizus, which is distinguished bt its vivid pink as well as dark purple skin along with red or white flesh, as well as Hylocereus undatus, which is known for its red or pink skin with white flesh. There is a strong emphasis on nutritional content, highlighting the special makeup of dragon fruit. The fruit is well known for having little calories and fat and for being high in fibre, vitamin C, antioxidants and other minerals, among other vital nutrients. Varied dragon fruit cultivars have varied nutrient profiles, which might provide useful information for those looking for certain health benefits.

Dragon fruit also has antioxidant qualities, immunological support, and possible anti-inflammatory actions. It is a great option for digestive health because it contains nutritional fibre. There are also cultural importance and culinary flexibility of dragon fruit, in addition to its nutritional elements. Dragon fruit's allure goes beyond its nutritional qualities, as seen by its traditional medical applications in certain cultures and its incorporation into contemporary cuisine.

Keywords: Yellow dragon fruit, pitaya, low calories, heart health, anti-inflammatory effect

Introduction

Fruits and vegetables are considered as very beneficial component which are used for preventing various types of chronic diseases. Increase intake of

fruits and vegetables not only enrich human diet but also helps in treating numerous kind of diseases (Maulidiani *et al.*, 2018). In comparison, consumption of fruits mainly are low in developing countries due to lifestyle patterns. Healthy diet is very important for managing and also to decreasing the chances of chronic diseases (Vainio *et al.*, 2006). Dragon fruit (another name is pitaya fruit), is full of various types of nutrients and antioxidants. This fruit is belonging to cactus species from the family Cactaceae (Patwary *et al.*, 2013). This fruit is first found from the sub-tropical and tropical area of forest of south and middle America and Mexico (Mizrahi *et al.*, 1997). There are some places where this is well cultivated such as Israel, Cambodia, Japan, China, Australia, Sri Lanka, Taiwan, Spain, Peru, Philippines, Vietnam, South western USA, Thailand (Mizrahi and Nerd., 1999; Nobel and D la Barrera., 2002).

Dragon fruits have health benefits and industrial significance and that is why it has become more widely cultivated in recent years. This has allowed for the use of the fruit as an origin of functional materials that offer potent antioxidant phytochemicals (Parmar *et al.*, 2019). Although this plant is very famous for it's fascinating appearance (Liaotrakoon., 2013). It gains popularity for its nutritional as well as restorative benefits (Sonawane., 2017). This is an edible and antioxidant rich food with good taste and crusty in nature (Rao and Sasanka., 2015). Antioxidants included such as hydroxycinnamates, betalains and flavonoids (Moshfeghi *et al.*, 2013). Although high amount of water-soluble fibre and ascorbic acid can be found in this (Moshfeghi *et al.*, 2013). It is used for its several health benefits which can show impact in weight loss, boost the immune system, helps in improving digestion and also helps in balancing cholesterol level by reducing LDL in blood. Studies shows that Hydroxycinnamates have anti-cancer properties and flavonoids is able to manage acts on blood arteries and brain cells, thus it can diminished probability of heart diseases. Moreover, it shields the body from germs and fungi and assist human's usual body functions (Verma *et al.*, 2017). Pitaya fruits are high in antioxidants, phytochemicals, nutrients such as calcium, phosphorus, and magnesium (Mahdi *et al.*, 2018; Luo *et al.*, 2014; Sushmitha and Sathyamurthy., 2018). For having tempting outlook and colour, and nutritional benefits, dragon fruits have gained popularity especially in Asian nations (Harivaindaran *et al.*, 2008; Hoa *et al.*, 2006).

Types of dragon fruit

Generally speaking, three varieties of the fruit are cultivated in diverse nations. Each has such surface or peel that is bit leafy and thickened. The three species of Hylocereus fruit can be found are: white pulp with red-peel

(Hylocereus undatus), red-pulp with red peel (Hylocereus costaricensis), and white-pulp with yellow peel (Hylocereus megalanthus) (Hunt., 2006; Hamidah *et al.*, 2017). These classifications can be more described (Britton and Rose., 1963).

Hylocereus undatus

It is a rosy coloured red fruit with long and green coloured stems. The flesh colour of this species is white. The form of flesh is good and tasty and have plentiful tiny black seeds. The length of the flower is up to 29 cm.

Hylocereus costaricensis

This can be described as ornamental vine with white stems (waxy). The flesh colour of this is red which has pleasant texture and taste. This flesh is also have tiny black seeds. The fruit is covered with scales of different sizes.

Hylocereus megalanthus (Hunt., 2006; Hamidah *et al.*, 2017)

It is a yellow coloured dragon fruit with white flesh. The flesh is contains small black seeds.

Histology of dragon fruit

Dragon fruit plant is looked like thin and leafless with branches. The height can be seen up to 1.5 to 2.5 meters. The plant has greenish stems (Patel and Ishnava., 2019) with soft and vine like branches divided into segment. The colour of flowers of this plant is white and fruits can be seen in bell shape. Fruits size are usually 25-30 cm long and 15-17 cm broad (Merten., 2003).

The fruit has red or white pulp and red peel contains with a huge amount of small black seeds (Patwary *et al.*, 2013). Usually three types of dragon fruit species are found that are - Hylocereus undatus, Hylocereus costaricensis, Hylocereus megalanthus (Hunt., 2006; Hamidah *et al.*, 2017).

Nutritional profile

There are some factors which may responsible for how nutritious dragon fruit is such as place of origin, species, and time of harvest (Liaotrakoon., 2013). The rising environment has a significant effect on the composition of nutrition and phytonutrient qualities of red pitaya fruit (Nurul and Asmah., 2014). Significant concentrations of minerals, including phosphorus, potassium,magnesium and salt are found in dragon fruit. Studies found that these amounts are greater in dragon fruit than those found in mango, pineapple, mangosteen (To *et al.*, 1999; Stintzing *et al.*, 2003; Gunasena *et al.*, 2007) and all other vitamin originators (Choo and Yong., 2011). Total soluble solids is higher in developed dragon fruits which is basically found in June to

October as these are the peak months for most varieties compared to other months (Nomura and Yonemoto., 2005). This fruit is a fine source of fructose, glucose, minerals, vitamins and dietary fibre (Rao and Sasanka., 2015). It is generally known for its abundant phosphorus, vitamin C, calcium and antioxidant components (Morton., 1987). Moisture, protein, fat, and fibre are present in fresh fruit. Calcium, Phosphorous, Iron, and Vitamin C are found in fresh fruit pulp (TFIDRA., 2005). Also dragon fruit can fulfill the increasing demand of consumers for antioxidant product and natural food colouring agent as the red pulp of this fruit is naturally high in Betalains content (Perween *et al.*, 2018).

These are the amount of nutrients in g or mg /100 gm portion that are present in white pulp dragon fruit (Jaafar *et al.*, 2009) :

Nutrient	**Amount**	**Nutrient**	**Amount**
Moisture	85.3%	Sorbitol	0.33
Protein	1.1	Ascorbic acid(vit C)	3.0
Fat	0.57	Retinol (vit A)	0.01
Crude fibre	1.34	Niacin	2.8
Energy	67.7	Calcium	10.2
Ash	0.56	Iron	3.37
CHO	11.2	Magnesium	38.9
Glucose	5.7	Phosphorus	27.75
Fructose	3.2	Potassium	272.0
Sucrose	Not detected	Sodium	8.9
-	-	Zinc	0.35

These are the amount of nutrients in g or mg /100 gm portion that are present in red pulp dragon fruit (Jaafar *et al.*, 2009):

Nutrient	**Amount**	**Nutrient**	**Amount**
Ascorbic acid	8-9	Fat	0.21-0.61
Protein	0.159-0.229	Crude fibre	0.7-0.9
Moisture	82.5-83.0		

Dragon fruit is high in ascorbic acid (vit C), thiamine (vit B_1), niacin (vit B_3), riboflavin (vit B_2), fibre, and minerals such as phosphorus, iron, and calcium. Dragon fruit is low in carbohydrates and has no fats. However, the seeds of the fruit consist of essential fatty acids (50%), namely linolenic acids, linoleic acids etc (Sonawane., 2017). Dragon fruit's predeveloped stem contains more ascorbic acids than the pulp of the fruit, which may help to reducing the risk factors for certain diseases such as weakness, anaemia and

scurvy (Jaafar *et al.*, 2009). The black seeds of this fruits are contains with essential fatty acids that are very much beneficial (Ortiz-Hernandez and Carrillo-Salazar., 2012). Phytochemical compounds found in the pulp and peel of dragon fruit have anti-microbial properties and can act as natural antioxidants (Patel and Ishnava., 2019). It is stated that all the mentioned informations indicated that the vitamins and mineral components of dragon fruit is important for maintaining a healthy diet.

Health advantages of different types of dragon fruit

As already discussed, pitaya or dragon fruit is full of healthful nutrients which is essential for human body such as antioxidants, dietary fibre, complex carbohydrates, vitamins, minerals etc. Some health advantages such as:

- **Anti-oxidative property:** Betacyanin is known as a reddish or purple pigment or hue which have anti-oxidative characteristics. Dragon fruits activates the growth promoting activity of gut microbiome and betacyanin which are healthy for human health (Liaotrakoon., 2013).
- **Role in CVD:** Dragon fruit diminish cardio vascular heart issues and helps in regulate blood pressure because of its low calorie, antioxidant rich and cholesterol free properties(Patel and Ishnava., 2019).
- **Acts as probiotics:** The flesh or pulp of dragon fruit contains a lot of mixed oligosaccharides (Wichienchot *et al.*, 2010) and polysaccharides (Xu *et al.*, 2016), which promote the growth of Bifidobacteria and Lactobacilli. These gastrointestinal microorganisms are probiotics which restrict the development of gastrointestinal pathogens. Dragon fruit is also a great source of natural probiotic (Sonawane., 2017).
- **Role of seeds:** The juicy pulp of this fruit is filled with many tiny black seeds that are effective source of micronutrients and antioxidants (Mahattanatawee *et al.*, 2006; Lim *et al.*, 2007; Ariffin *et al.*, 2009; Jaafar *et al.*, 2009; Lim *et al.*, 2010).
- **In other cases:** These fruits have the potential of wounds and cuts healing, improvement of vision, appetite and memorization of a person (Rao and Sasanka., 2015).

It possesses qualities that delay aging (Zhuang *et al.*, 2012; Lim *et al.*, 2012), effects that prevent cancer (Yusof *et al.*, 2012), favourable impact on oxidative stress, diabetes, cardiovascular disorders, immunological system,

metabolism, and clarity of vision (Nurmahani *et al.*, 2012), as well as reduction of aortic stiffness (Kumar *et al.*, 2018).

- **Beneficial for diabetes and many more:** It is used to treat diabetes and fortifies the immune system. Its bloom and stem can be used to make medicine that increases blood flow. The compounds in dragon fruits reduce cholesterol, manage diabetes, and stave off arthritis and asthma (Cheah *et al.*, 2016).
- **For pregnant woman:** This is also very healthy for pregnant women because it is rich in iron which can enhances the erythrocyte and haemoglobin level (Nurliyana *et al.*, 2010).
- **Also rich in omega3 and 6 fatty acids:** The seeds can help in reduction of triglycerides as well as risk of CVD due to its omega 3 fatty acids, omega 6 fatty acids and polyunsaturated fats content (Sonawane., 2017).
- **Other nutrients:** It contains an elevated degree of phosphorus and calcium; it assists with supporting bones and assume a significant part in tissue development and structures of teeth (Choo and Yong., 2011). Dragon fruit, which is rich in Vitamin C, would help in treating cough and asthma on a regular basis (Cheah *et al.*, 2016).
- **Role in physical and mental health:** There is an antioxidant and bioactive free radical decomposer "polyphenolic compound ", present in dragon fruit which helps to boost immunity (Barros *et al.*, 2015). Besides of that it also develops one's wellness i,e mental and physical health (Jeronimo *et al.*, 2017).

This fruit is getting a lot of attention worldwide because of its high benefits of not only in healthcare but also in food processing, nutraceutical, cosmeceutical field etc.

Agricultural processes of dragon fruit in India:

Dragon fruit first effectively cultivated in the Gujrat state. Nowdays the cultivation is also started in various places in West Bengal.

- **Planting weight and expansion**

H. costaricensis and H. undatus can be quite simply propagated by chopping off the stem when it touches the ground (Fouqué, 1969). Under West Bengal condition, it takes 14 months to come to permit. Nonetheless, the time span may fluctuate depending on the various location and climate. Seeds may take three years to come to permit if used in the cultivation. As long as the

cuttings are at least 50 to 70 cm long (N'Guyen, 1996) and receive frequent irrigation, good roots should be achieved. Roughly 90% of the cuttings will guarantee roots if all these requirements are met (Le Bellec, 2003). Sixty thousand four hundred plants per ha can be adapt by planting at a spacing of 2.5 m between each plant in a row and with four cuttings per supports within each plant. This method produces better fruit supply and attribute (Anon, 2017).

Context of cultivation

It is not advisable to grow dragon fruit directly on the ground for two reasons; first it makes the farming more challenging and furthermore the vines got spoiled when in contact with the ground (Le Bellec, 2003). That's why it is better to grow this fruit on either alive or dead supports (De Dios *et al.*, 2000 and Barbeau., 1990).

In any critical atmosphere like low temperature or drought, the development of plant become fast and repeated. Pruning is crucial when using both vertical and horizontal supports, and the stems chosen should encourage that to go up the whole support. The main stems and branch stems should be preserved, with the exception of those that contact the ground and all lateral growth and plant portions facing the ground should be cut off (Le Belle, 2003).

Need for irrigation and mineral nutrition

Appropriate nutrient requirements are necessary for the crop's improved growth performance. The shallow root system of the pitaya is capable of quickly assimilating even very little amounts of nutrients.

Though dragon fruit can endure months of dryness and extremely little rainfall, it still need a consistent source of water in case the need of high-quality fruits. Frequent irrigation is essential as it helps the plant to accumulate enough reserves to guarantee fruit growth and flowering at the most advantageous moment.

It is advised to use micro-irrigation. Apart from the effective water delivery provided by this technique, micro-irrigation prevents excessive and uneven watering, which may cause the blossoms and early fruits to drop off (Barbeau., 1990).

The cutting and gathering of food crops after their maturation

Colour changing of fruit peel can be seen extremely late in the maturity stage. Based on the species, it may take twenty-five or twenty-seven days after flowering for the skin to turn reddish or pink (Nerd *et al.*, 1999). In the case of H. costaricensis, first the plantation of cutting should be done in the west

Bengal circumstances. Then the very first harvest most probably starts from 14th months (Barbeau., 1990 and Le Bellec., 2004).

Insects and Diseases

In Hylocereus, some irritant are identified that are Ants from subdivision Solenopsis (N'Guyen, 1996 and Le Bellec, 2004) and Atta (Barbeau, 1990) are well-known as it can seriously harm plants as well as their fruits and flowers. Besides of that many others have been found that are various aphids species, birds, rats.

Conclusion:

From a business standpoint, dragon fruit appears to be having a lot working for them. Growers from all over India are drawn to them by their charming colour, appearance and superior nutritional value. At room temperature, fruits are readily kept fresh. There are various manufactured items that can be prepared using the fruit pulp. This fruit has a lot of vitamins, minerals, fructose, glucose, and dietary fibre. The body's resistance against illness was boosted by the combination of all the components found in dragon fruits. Because of its adaptability, the crop can thrive in any climate that supports flowering and fruiting as far as the soil has sufficient drainage. In addition to bearing fruit quickly, they are now free of numerous pests and diseases.

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Chapter - 5
An Overview on Utilization of Various Fruit and Vegetable Pomace as an Effective Ingredient

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Chapter - 5

An Overview on Utilization of Various Fruit and Vegetable Pomace as an Effective Ingredient

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Abstract

Pomace is the discarded part of fruit and vegetable remains after pressing or extracting the juice. Utilization of pomace of various fruits and vegetables becomes a great concern in food processing industries. This research paper will discuss about the necessary for consumption of pomace when it gets combined with other products or else when it gets fortified. Different valuable food products can be fortified with pomace such as bakery items like biscuits, cakes, muffins, also can be fortified with breads, pastas, chowmein, chips etc. We use some of the food products in our daily life so it may be helpful to change our lifestyle and becomes healthy for consumption on daily basis. Likewise, olive pomace, mustard pomace are used to extract oil. This paper will also discuss about other properties present in pomace such as antioxidant properties, phenolic compounds including minerals. Furthermore it can be also works as a functional food, food additives as well as supplements. The results will revealed that how it works in our health and gets benefitted in future generation. This paper will also show the correlation between the intake of pomace and dietary fibre. Our research will healthify mostly adolescents, school goers and teenagers as they refuse to take fibre in their diet, thus if we fortified the products with pomace it will be beneficial for them to receive fibre-enriched foods in their diet. Last but not the least it will also emphasize on Waste Management, if we utilize the pomace after taking out pulp then it will not create any pollution and will become environment friendly for us.

Keywords: Adolescents, mustard pomace, fibre-enriched foods

Introduction

From ancient times, people survive in the Earth depending on the food. Food is one of the most important as well as basic need of life (Clapp, 2020). Pomace are the by-products that are extracted after pressing or crushing the fruits and vegetables which is considered as good for consumption at present

days (Shalini & Gupta, 2010). It is rich in fibre content which is one the essential nutrient required for our body (Sahni & Shere, 2018). The waste products from various fruits and vegetables are increasing day-by-day (Kusumasari *et al.*, 2024). Almost 20.9 million tonnes waste products are taken out every year according to United Nation Environment Program (UNEP) in 2021 (Kusumasari *et al.*, 2024). Discarded peels of fruits and vegetables gets are considered as waste materials, but we all know that it can be consumed to increase fibre intake (Sagar *et al.*, 2018). On the basis of WSDE (1994) report came to a conclusion on wastage reduction, increment of demand as well as profit and make good relations with public (Sagar *et al.*, 2018). Food processing industries are the main centers of generating waste products, but now-a-days food processing industries raise hand to convert those wastage products into valuable products (Omre, 2018). This review will discuss about the purpose of taking the fruits and vegetable pomace as an edible ingredient in consideration. Also, our focus is on what are the necessary nutrients that we will receive from the discarded parts of fruits and vegetables after processing the fruits and vegetables.

Dietary fibre as a blessings to health

Most of the people in Western world are deprived of their dietary lifestyle, especially it lacks in fibre enriched foods (Barber *et al.*, 2020). It consists of variety of good points that can be considered for good lifestyle such as stool bulking, decrease in cholesterol level, improves the health of gut microbiome, lowering in glycemic index (Hojsak *et al.*, 2020). People with sufficient intake of fibre are proved to be shown in reducing various chronic illness because of having beneficial effects on consuming dietary fibre (Chhabra, 2018). Insufficient fibre enriched foods in diet may leads to several health problems such as irritable bowel syndrome (IBS), constipation, allergies (Hojsak *et al.*, 2020). Whole grains extracted from cereals and pseudo-cereals contains high amount of both soluble and insoluble fibres such as cellulose, arabinoxylan, fructan etc. (Joye, 2020). Consumption of dietary fibre in large amount may decrease the chance of introducing cardiovascular disease (CVD), lowers blood pressure and other heart related diseases by lowering low-density lipoprotein or “bad” cholesterol levels (Reynolds *et al.*, 2022). We all know that large intestine is the home of various microflora that resides in the gut which aims in the process of both absorption and digestion where dietary fibre is the main source of energy that affects the microfloral population extremely (Brownlee, 2011). The range for consuming dietary fibre varies according to different age group such as in elderlies 11.6g/day, in adults it is about 10.6g/day whereas in adolescents it is 8.5g/day (Seljak *et al.*, 2021). Thus, we

can say dietary fibre should be focused on public health strategies that includes formulation or production of new foods, alteration can be done to promote whole-meal, intake of plant-based foods which leads to an overall contribution in dietary fibre consumption (Seljak *et al.*, 2021).

Hidden gems of fruits and vegetable pomace utilized in development of food products

Utilization of pomace plays an integral part in waste management generated from food industry (Khedkar, 2014). There should be various kinds of technologies that are employed for managing the waste products generated from industries (Khedkar, 2014). Non-usable by-products such as pomace, seed coat, husk, hull may become concern to the environment (Lau *et al.*, 2021). By using the by-products coming from vegetables and fruits may leads to the increment in sustainability of food in collaboration with United Nations Sustainable Development Goal (SDG) that differs in the production pattern (Lau *et al.*, 2021). Apple pomace is a by-product derived after processing of apples that is a great source of carbohydrates, dietary fibre, antioxidant, and phenolic compounds which is fortified to make desirable functional foods such as bakery products, dairy products, meat products to enhance market value and health benefits has been briefly elaborated (Muhammad *et al.*, 2023). According to some research, food product obtained from wheat bran and fragmented apple pomace had the greatest amount of fibre and simple sugar, high levels of polyphenols (Sobczak, 2022). Recently, consumption of phenolic-rich supplements and foods are very much essential for keeping healthy lifestyle, pomace extracted from grape has phytochemical constituent which includes antioxidant, antimicrobial and biological activities (Wani *et al.*, 2023). The leftover portion of wine after fermentation in the container and the residual part after pressing grapes contains various types of nutrients are utilized to make valuable products despite being utilization in wine making process (Kokkinomagoulos & Kandylis, 2020). The residual part of grapes is mainly used as a substitute of phenolic compounds, works as a substrate in production of alcohol and a good source of fertilizer in vineyard (Kokkinomagoulos & Kandylis, 2020). Most of the customers demand for highly nutritious, healthy, low calorie, fat free food products. Jamun pomace powder becomes essential in the production of flavorful, nutritious, and low-calorie ice creams, plays a great role in preventing various diseases, have numerous health points and decrease free radicals (Shelke *et al.*, 2020). In recent studies, it is found that jamun pulp residue has anti-diabetic, anti-carcinogenic, hepatoprotective, anti-carcinogenic properties, also acts as a great influencer of liver stimulant, digestive key, cooling agent etc. (Kumar *et*

al., 2023). Beetroot pomace is also of great importance as it contains high level of betalains and phytochemicals. It is also considered as a good source of antioxidant, dietary fibre, and bioactive compounds (Theba *et al.*, 2021). Beetroot pomace is processed to make powder and further fortification is done to produce fortified cakes, biscuits, muffins, shakes, candies, snacks, chips, juice etc. (Theba *et al.*, 2021). A research study has been shown that beetroot pomace powder had been fortified with biscuits has a great effect on phenyl hydrazine induced anemia mostly seen in albino rats (Abdo *et al.*, 2021). It had a challenging effect for high level of hemoglobin production, RBCs, and antioxidant enzymes in rats in less than 30 days and also recovers the abnormal functioning of kidney and liver in rats (Abdo *et al.*, 2021). Thus, we can conclude that beetroot pomace has a major impact in treatment of anemia (Abdo *et al.*, 2021). Beetroot pomace has an indispensable phytochemical compound brings a great concern pharmacological aspect (Afzaal., 2022). Besides this, it is also a good source of vitamins, minerals phytonutrients and other important components. (Afzaal *et al.*, 2022). The beetroot peel powder has a high betalain content, polyphenolic content, and antioxidant activity (Lazăr, *et al.*, 2022). Beetroot peel powder-fortified-mayonnaise is a recent product developed shows a valuable impact on sensory properties, composition of phytochemicals, taste, reddish-color, smell, and viscosity (Lazar *et al.*, 2022). This beetroot peel powder-enriched mayonnaise brings a great taste while used in sauces, dressings, creams (Lazar *et al.*, 2022). Another arising new product in market came into concern for diabetic patients that is firstly beetroot pomace is de-sugared to produce varieties of cupcakes which is good for high fibre content (Zagorulko *et al.*, 2022). Consumption of carrot is vast and extraction of carrot pomace is high in industries after extracting juice (Luca *et al.*, 2022). Mainly carrot pomace powder is generated from four kinds of carrots such as Baltimore, Niagara, Belgrado and Sirkana having great source of beta carotene, riboflavin, thiamine, folic acid, and vitamin B-complex (Luca *et al.*, 2022). Tańska *et al.* proved that incorporation of carrot pomace in a wheat bread rather than using wheat flour brings a good content of dietary fibre whereas condensed milk fortified with carrot pomace powder has a great impact in market value as well (Luca *et al.*, 2022). Different experiments and demonstrations had been taken place to produce fibre-rich biscuits by using finger millet flour and carrot pomace powder is beneficial for our health (Nasir *et al.*, 2020). Except antioxidant and beta carotene, phenolic content is also high in 10% carrot pomace powder-fortified-breads rather than any other formulated breads (Begum *et al.*, 2023). Cucumber is the most consumed food used in salad dressings and its pomace contains high amount of minerals, fibres, polyphenols, and flavonoids (Saad

et al., 2021). Pomace is used to prepare pasta of different colors and is usually rich in antioxidant (Kaur *et al.*, 2022). Pomace powder extracted from orange and pomace powder extracted from cucumber and are employed to produce tricolor pasta (Kaur *et al.*, 2022). Soilless plant culture is an innovation towards the agricultural field, where plant is cultivated in absence of soil by maintaining the size, shape, texture, pH, electrical conductivity, and overall production of crops (Rahil *et al.*, 2021). An experiment was done where olive pomace works as a growing medium for cultivating eggplant but due to high saline content in olive pomace the plant growth gets hampered (Rahil *et al.*, 2021). Globally, 170 million tons of tomatoes yield every year and a huge amount of tomato pomace extracted out after processing which contains high amount of water with various nutrients (Lu *et al.*, 2022). It has been already proved that tomato pomace is rich in lycopene, flavonoids and is best known for its antioxidant properties, works as a brilliant animal feed, has better growth, increment in PUFA levels, improves the texture and color of the meat, and becomes tenderized (Lu *et al.*, 2022). A recent study was introduced working with various gases such as argon, helium, nitrogen is High Voltage Atmospheric Cold Plasma (HVACP) that leads to the changes in pomace of tomatoes focusing in the extraction of phenolic compounds (Bao *et al.*, 2020). Industries generates huge amount of pomace from potato as well as pomace produced after extraction of juice from sweet lime pulp and these waste products are utilized to form packaging films that are completely biodegradable (Borah *et al.*, 2017). Application of ultrasound helps in the breakage of biopolymer particles when dipped in film forming solution that ranges between 45 to at least 60 mins (Borah *et al.*, 2017). Berry pomace has a high source of polyphenols and anthocyanins (Nemetz *et al.*, 2021). Berry pomace generally extracted from chokeberry, bilberry and elderberry are concentrated to generate different coloring agents (Nemetz *et al.*, 2021). In North America, blueberries and cranberries are produced in wide range which leads to the production of huge amount of pomace (Celli & Kovalesk, 2019). Blueberry pomace covers about 20% of the remaining fruit after being processed or extracted the pulp (Celli & Kovalesk, 2019). It is considered as a rich source of bioactive compounds and fibres including anthocyanins and proanthocyanins in their skins, which acts as a natural coloring agent to bring blue color in any food products (Celli & Kovalesk, 2019). Organic wastes such as discarded peels and pomace from various fruits and vegetables coming from agricultural industries and food industries has become a major problem that hampers environment and our surroundings (Rojas-Flores *et al.*, 2021). In a recent study, we came to know that Microbial Fuel Cells (MFC) has a capability of producing bioelectricity utilizing waste products as a fuel which

will indirectly leads to waste management and pollution control (Rojas-Flores *et al.*, 2021). A current of 1.130 mA and voltage of 1.127 V can be produced using zinc and copper electrodes where blueberry wastes work as a fuel which will also indirectly leads to decrease in global warming (Rojas-Flores *et al.*, 2021).

Significance and effect of pomace towards healthy lifestyle and towards waste management

From the above discussion we can concluded that pomace had a great impact to have a change in lifestyle as well as it will also have some nutritive points for all age groups specially teenagers, adolescents, and school-goers. Moreover, it will also have a great impact on environment by controlling pollution. Healthy diet includes mediterranean diet which is a rich source of antioxidant and fibre that can be generally obtained from wine grape pomace (Urquiaga *et al.*, 2015). It helps to reduce hypertension, prevents damage of protein, reduces the blood glucose level, and helps to prevent metabolic syndrome (Urquiaga *et al.*, 2015). Oil extracted from olive pomace is another thing that is well-known in the prevention of any type of heart problems or heart related diseases (Cala *et al.*, 2019). It has a high level of oleanolic acid which had a positive impact on cardiovascular dysfunction and others related to metabolic problems (Cala *et al.*, 2019). We all know that pomace is mainly rich in dietary fibre which increases the digestion process effectively as well as helps to increase the number of bowel movements (Patel *et al.*, 2020). Carrot pomace enriched bread leads to increase the levels of dietary fibre by 238% that will help to keep our body fit by preventing constipation and chronic diseases (Patel *et al.*, 2020). Pomace also had a negative impact on environment. Most of the fruit and vegetable processing industries extracts huge amount of pomace on daily basis (Gassara *et al.*, 2011). It is a biodegradable waste that can increase the Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) levels (Gassara *et al.*, 2011). It is important to take into consideration about the management of pomace waste by different processes such as landfilling, composting (Gassara *et al.*, 2011). It leads to the emission of tremendous Green House Gases (GHG) which emerges pollution targets respiratory system leads to the emergence of bronchitis, asthma, Chronic Obstructive Pulmonary Disease (COPD) and other respiratory related disorders and effect Central Nervous System (CNS) and immune system (Gassara *et al.*, 2011). A research study has evidence of producing various types of polymeric composites in a combination of grape pomace residue collected from vineyards and pinewood leftovers collected from sawmills (Berger *et al.*, 2020). Pinewood particles along with grape

pomace become a viable proxy in the idea of reducing plastics based on petroleum (Berger *et al.*, 2020). Apple pomace is an ill-suited for landfilling as well as feed for animals due to high sugars and acidic content (Gustafsson & Landberg, 2018). Apple pomace is a new approach to promote the production of bio-plastics that are considered as an acceptable material (Gustafsson & Landberg, 2018). To generate bioplastic materials two methods were introduced: solution casting and compression molding, where glycerol is considered as a plasticizer (Gustafsson & Landberg, 2018). There are various possibilities of taking apple pomace as an advantageous ingredient in production of biofilms and 3 Dimensional (3D) shapes have been already explored (Gustafsson & Landberg, 2018). In research it is shown that, various essential qualities of packaging materials are determined from cassava pomace (Akmeemana *et al.*, 2023). Qualities that are put in consideration are permeable to water vapor, moisture content, light barrier properties, mechanical properties, Fourier Transform Infrared Spectroscopy (FT-IR) analysis, biodegradation, thickness, color, thermal stability and the plasticizers characters, this biodegradable plastics work as a control towards pollution and leads to the management of waste (Akmeemana *et al.*, 2023). The Food and Agricultural Organization (FAO) evaluated that 20% to 30% of fruits and vegetables generates which leads to the introduction of bio-based polymers which is interlinked to environment pollution and generates synthetic plastics such as polypropylene (PP) and polyethylene (PET) as 9% of 400 million tons synthetic plastics gets recycled every year (Maraveas, 2020). Biofilms are applied in the production of intelligent packaging instead of producing synthetic plastics (Maraveas, 2020).

Conclusion

Fruit and vegetable pomace can be used to improve the functionality of food for its functional characterises. Variety of fruit and vegetable pomaces are being used in wide array of bakery products like biscuits, buns, cookies, crackers, cakes, muffins, wheat rolls. Fruit pomaces tend to be well suited for bakery products and provide them better sensory properties. An uni utility of fruit and vegetable pomace is the enhancement of the storage quality of baked products due to its prese antioxidants. Thus, fruit and vegetable pomace can be used as effective functional ingredient in food products.

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Chapter - 6
Nutrition and Dietary Management for ADHD -A Comprehensive Review

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Chapter - 6

Nutrition and Dietary Management for ADHD -A Comprehensive Review

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Abstract

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common psychological disorders in children and adolescents which effects on Mental health, Social Communication and lifestyle. Case Studies have shown that proper dietary intake may balance the risk of ADHD. The management of ADHD includes nutritional supplements, gut microbiome-targeted interventions with biotics, and elimination diets. The aim of this review is to find out the suitable dietary patterns and connection with nutrients which are most associated with ADHD and the clinical use of dietary interventions. Research shown that appropriate dietary patterns can reduce the risk of ADHD. As a nutritional supplements, only vitamin D and vitamin D + magnesium helps to improve ADHD. Regarding biotics, evidence was only found for Lactobacillus rhamnosus GG.

Keywords: ADHD, dietary interventions, dietary patterns, management, nutrients

Introduction

ADHD (Attention Deficit Hyperactivity Disorder) is a psychological disorder that can affect the mental health, social interaction, and lifestyle of children and adolescents. According to case studies, proper dietary intake can balance the risk of ADHD. Biological interventions targeting the gut microbiome, nutritional supplements, and elimination diets are used to treat ADHD. The etiology of ADHD relies on both genetic and environmental factors. Diet, as a modifiable environmental factor, has been investigated as a potential therapy option in ADHD. Moreover, dietary patterns may influence the risk of ADHD since patterns described as “junk-food,” processed food”, “snack”, “sweet”, have been positively associated with this pathology. Diets to reduce symptoms associated with ADHD include sugar-restricted, additive/preservative-free, oligoantigenic/elimination, and fatty acid

supplements. Omega-3 supplement is the latest dietary treatment with positive reports of efficacy, and interest in the additive-free diet of the 1970s is occasionally revived.

Dietary patterns

For ADHD Processed foods, increased take-away foods, edible oils, and sugar-sweetened beverages, and all these changes have had negative effects on the health of many populations around the world.

The relationship between dietary patterns and ADHD has yielded impactful results, some studies showing that a healthy eating pattern and specific dietary management could significantly decrease the risk of ADHD.

A healthy dietary pattern with consumption of fruits and vegetables, fish, and high in PUFAs and micronutrients such as magnesium, zinc, and phytochemicals seems to decrease the risk of ADHD by 37%. On the other hand, junk food and processed food in dietary patterns, consumed by children, increase the risk of ADHD. The Diet rich in red and processed meats, refined cereal grains, soft drinks, and hydrogenated fats, was shown to increase the risk of ADHD by 92%. while the junk food pattern, characterized by a high consumption of processed foods, with high amounts of artificial food coloring (AFC) and sugar, was found to increase the risk by 51%.

In conclusion, dietary patterns seem to play a potential role in the risk of ADHD, as patterns described as “Junk-food”, “Processed”, “Snack”, “Sweet” are associated with this pathology, whereas healthy eating patterns, such as the Mediterranean diet, are inversely associated with ADHD.

Nutritional and supplements

As a management options for ADHD, they mostly focus on dietary supplements with vitamins, minerals, and PUFAs, microbiome-targeted interventions with pre-, pro-, and synbiotics, and specific diets such as restricted diets.

A systematic review and meta-analysis of four randomized controlled trials (RCT), with a total of 6 children, addressing vitamin D, Zinc and Iron supplementation as an adjunctive therapy to methylphenidate, demonstrated a small but statistically significant improvement in ADHD total scores, inattention, hyperactivity, and behavior scores.

Dietary interventions

Intervention trials with nutritional supplements (zinc, iron, and vitamin D) in ADHD

Table 1: Zinc Supplements trials

S. No.	Sample	Age	Intervention Period	Results
1.	Aradhya Santra	11	15mg Zinc/day 6 weeks	+Inattention score +Socialization symptoms
2.	Najir Mallick	8	10mg Zinc /day 6 weeks	+Hyperactive +Impulsive - Socialitation symptoms
3.	Kushal Hait	10	12mg Zinc /day 6 weeks	+ Inattentative levels - Hyperactive-impulsive symptoms
4.	Sahid Mallick	12	15mg Zinc /day 6 weeks	+Emotional Problems - Inattentative levels
5.	Mariya Khatun	7	10mg Zinc /day 6 weeks	+Hyperactivity levels - Peer problems
6.	Sabnam Parvin	9	10mg Zinc /day 6 weeks	+Emotional problems +Inattentative Score

Table 2: Iron supplements trials

S. No.	Sample	Age	Intervention Period	Results
1.	Aradhya Santra	11	3.5 mg ferrous sulfate/day 6 weeks	+Inattention score +Socialization symptoms
2.	Najir Mallick	8	2.2mg ferrous sulphate/day 6 weeks	+Hyperactive +Impulsive - Socialitation symptoms
3.	Kushal Hait	10	3mg ferrous sulphate/day 6 weeks	+ Inattentative levels - Hyperactive-impulsive symptoms
4.	Sahid Mallick	12	3.5 mg ferrous sulphate /day 6 weeks	+Emotional Problems - Inattentative levels
5.	Mariya Khatun	7	2mg ferrous sulphate /day 6 weeks	+Hyperactivity levels - Peer problems
6.	Sabnam Parvin	9	2.3 mg ferrous sulphate /day 6 weeks	+Emotional problems +Inattentative Score

Table 3: Vitamin D supplements Trials

S No.	Sample	Age	Intervention Period	Results
1.	Aradhya Santra	11	30,000 IU/week 6 weeks	+Inattention score +Socialization symptoms
2.	Najir Mallick	8	25,000 IU/ week 6 weeks	+Hyperactive +Impulsive - Socialitation symptoms
3.	Kushal Hait	10	30,000IU/week 6 weeks	+ Inattentative levels - Hyperactive-impulsive symptoms

4	Sahid Mallick	12	30,000 IU/ week 6 weeks	+Emotional Problems - Inattentative levels
5	Mariya Khatun	7	25,000 IU/ week 6 weeks	+Hyperactivity levels - Peer problems
6	Sabnam Parvin	9	25,000 IU/ week 6 weeks	+Emotional problems +Inattentative Score

Table 4: Interventions Trials of PUFAs in ADHD

S. No.	Sample	Age	Intervention Period	Results
1.	Aradhya Santra	11	2 capsules of an Omega-3 fatty acid supplement 2 times/day 6 weeks	+Inattention score +Socialization symptoms
2.	Najir Mallick	8	2 capsules of an Omega -3 fatty acid 2 times /day 6 weeks	+Hyperactive +Impulsive - Socialitation symptoms
3.	Kushal Hait	10	2 capsules of an Omega- 3 - fatty acid 2 times /day 6 weeks	+ Inattentative levels - Hyperactive-impulsive symptoms
4.	Sahid Mallick	12	2 capsules of an Omega -3 fatty acid 2 times /day 6 weeks	+Emotional Problems - Inattentative levels
5.	Mariya Khatun	7	2 capsules of an Omega -3 fatty acid 2 times /day 6 weeks	+Hyperactivity levels - Peer problems
6.	Sabnam Parvin	9	2 capsules of an Omega – 3 fatty acid 2 times/day 6 weeks	+Emotional problems +Inattentative Score

Improved = +

Not Improved = -

The populations in the included studies consisted of the children with ADHD in the age group ranging from 6–18 years. The interventions consisted of supplements with Zinc, Iron, vitamin-D and PUFAs with omega 3 fatty acids. The interventions observed between 6 weeks.

Probiotic supplementation with daily *Lactobacillus rhamnosus* GG for 6 weeks seemed to improve physical, emotional, social, and school functioning in children and adolescents with ADHD, multi-species probiotic supplementation appeared to improve symptoms of ADHD. This multi-species probiotic supplementation included several strains of *Lactobacillus*, *Bifidobacterium*, *Bacillus*, and *Streptococcus* etc.

Factors affecting ADHD

- **Genetic factor:** Gene polymorphisms, consanguinity, heritability and parental status.
- **Environmental factor:** Maternal, Pre and Post natal, brain injury, toxins exposure and dietary.
- **Individual factors:** Age, Gender, birth weight, marriage status and brain chemistry.
- **Psychological factors:** Social support, loneliness, social disruption, work environment, social status and social intregration.
- **Neurological factors:** Neurotransmitter pathways, neurotransmitter receptor and functional status.
- **Associated disorders:** Fragile x syndrome, depression, anxiety, PTSD and sleep disorder.

Discussion

The findings of the observational studies emphasize a potential role of dietary patterns in ADHD; however, these study designs are unable to establish a causal relationship between diet and ADHD. Lifestyle factors (e.g., physical activity, screen time, and sleep) influence dietary patterns and may be important factors in ADHD symptomatology. In many of the included studies in this review, the dietary patterns derived from principal component analysis explained less than 50% of total variance, suggesting the influence of other patterns and factors.

From the clinical point of view, restriction and elimination diets can lead to nutritional deficiencies and, consequently, poor growth in children with ADHD, so the nutritional status of these children must be conscientiously monitored. These diets can be compared to the low-FODMAP diet used in Irritable Bowel Syndrome.

Conclusion

In ADHD, dietary patterns appear to play a significant role in the risk of developing or aggravating disease symptoms, with unhealthy patterns being most positively associated with this pathology, and healthy eating patterns being inversely associated with ADHD. Altered levels of nutrients, such as vitamin D, iron, zinc, and PUFAs, have also been associated with the aggravation and progression of ADHD. Therefore, diet has emerged as a treatment option for ADHD.

Future scope

It will be helpful for ADHD treatment in clinical pathways, the dietary patters and dietary management will improve the Gut health and Inattentive behaviour.

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Chapter - 7
A Comprehensive Review On- Curcumin and Its Role in Liver Disease

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Chapter - 7

A Comprehensive Review On- Curcumin and Its Role in Liver Disease

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Abstract

Turmeric is a spice made from the rhizomes of the Curcuma longa Linn plant. Curcumin is a physiologically active polyphenolic component found in turmeric. Growing preclinical research data indicates that curcumin exhibits antioxidant, anti-inflammatory, anticancer, and neuroprotective effects in addition to modulating several molecular targets. Even with all of its advantages, curcumin's bioavailability is poor. Since curcumin is less well absorbed when taken orally, its advantages are limited because aldo-keto reductase quickly metabolizes and excretes the compound in the liver and intestines. Curcumin's exposed -OH and -OCH3 sites can make bonds with glucuronidase and sulfate-conjugated substances to produce conjugates. When curcumin is delivered intraperitoneally or through other routes, it reduces to hexahydrocurcumin and octahedron-curcumin. The development of non-alcoholic fatty liver and consecutive fibrosis, and cirrhosis is facilitated by oxidative stress, which is a major contributing factor to liver damage. Examples of such stressors include alcohol, drugs, viral infections, environmental contaminants, and dietary components. Researches suggested that curcumin exhibited therapeutic and curative actions modulated by various cellular and mechanism against disorders of liver. These processes involve the inhibition of proinflammatory cytokines, lipid peroxidation products, PI3K/Akt, and activation of hepatic stellate cells. Additionally, they involve the enhancement of cellular responses to oxidative stress, including the production of Nrf2, SOD, CAT, GSH, GPX, and GR. All things considered, curcumin's phenolic, B-diketone, and methoxy groups work synergistically to scavenge free radicals and inhibit the action of various ROS. Over 10% of people die from liver illness, which usually progresses to liver cancer and cirrhosis.

Keywords: Curcumin, acute and chronic liver disease, cirrhosis, antioxidants, oxidative stress

Introduction

Liver diseases are of the leading incidence that affect various age group of individuals over the world. There has been significant advancement in the field of disease prevention strategies still liver disease continue to impact people. Over 10% of the global population suffers from liver illnesses, which typically lead to liver cancer and cirrhosis at final stages (Farzaei *et al.*, 2018). Curcuma longa is a well-known herb and considered a member of ginger family Zingiberaceae. The utility of curcumin expands as curry powder in many Asian cuisine. It is established to possess crucial biological functions. Curcumin has structural resemblance with the chemical composition of polyphenol. It played a significant role as traditional medicine in household treatment for various diseases. Many researchers studied the biological activity of curcumin and suggested that curcumin possesses antimicrobial, anti-inflammatory, antioxidant, immunomodulatory actions. Curcumin has been reported in therapeutic applications such as protection against retinal damage, cancer, hepatic disorders, through various pathways of molecular mechanisms. It has also been reported to modulate genetic expressions (Ghanaei *et al.*, 2018). Hepatocellular carcinoma (HCC) is a pathological condition that results from numerous complicated variables. Non-alcoholic fatty liver disease (NAFLD) might significantly enhance the progression of HCC. NAFLD can result as a consequence of higher liberation of reactive oxygen species (ROS) and response to chronic inflammatory conditions. If not treated NAFLD might lead to the development of non-alcoholic steatohepatitis (NASH). This ultimately promotes the growth of HCC by inducing hepatic fibrosis, which is defined by the extended extracellular matrix (ECM) deposition and prolonged activation of hepatic stellate cells. The varied process of metamorphosis highlights how intricately the disease develops (Li *et al.*, 2024). Various studies reported that curcuminoid substances can function as free-radical scavengers by inhibiting peroxidation. According to the researches, curcuminoid compounds can reduce lipid peroxidation caused by free radicals, thereby acting as free-radical scavengers. Curcumin-mediated inhibition of nuclear factor kB (NF-κB), which plays a critical role in initiating the inflammatory cascade in the majority of chronic disorders, has been one of the most significant discoveries in this field. Crucially, gene products that are dependent on NF-κB also inhibit cell death and encourage cell division, invasion, and angiogenesis (Riccardo *et al.*, 2017). It also reduces the production of triglycerides (TG) by inhibiting HMG-COA reductase leading to elimination of lipids from the liver. Additionally, it lowers the risk of cardiovascular diseases by improving lipid profiles by increasing the activation of cholesterol-7-alpha-hydroxilase and decreasing the absorption of cholesterol from the intestine (Jalali *et al.*, 2020).

Bioavailability of curcumin

Anti-oxidant, anti-inflammatory, and anti-tumoral properties of curcumin has recently attracted the attention of scientific community for utility as a potent bioactive in chronic disorders. The significant pharmacodynamic impact of curcumin remains elusive since there is a lack in preclinical trials. By the adverse pharmacokinetic characteristics of the drug. In actuality, curcumin demonstrated minimal absorption because of its poor water solubility and quick metabolism in the liver and intestines, which speed up its excretion. It also experiences significant hepatic biotransformation (via conjugation and CYP reduction enzymes with widespread excretion through the bile), is very unstable, and hydrolyzes quickly at physiological pH (Riccardo *et al.*, 2017). A significant amount of cur that is taken orally is eliminated through the feces, with just a tiny amount being absorbed in the gut. The cur then undergoes fast metabolism in the liver and plasma. In the small intestine, cur is primarily absorbed. The body's rapid clearance and elimination rate, high metabolic rate, and poor absorption may be the causes of the low oral bioavailability. Three physiological obstacles in the gastrointestinal tract are connected to impede oral administration (Ma *et al.*, 2019).

Development of liver diseases induced by oxidative stress

An unbalanced production and breakdown of reactive oxygen species (ROS) can lead to oxidative stress which leads to the production of free radicals and ultimately compromise cellular integrity. Curcumin has been suggested as a potent treatment for oxidative stress management in liver diseases. Various studies illustrated several key pathways of curcumin on protection of oxidative stress induced liver damage. Some studies utilized hydrogen peroxide as an agent capable of causing hepatic cell injury. According to the findings, curcumin inhibited liver damage and reduced the amounts of important hepatic enzymes such as alkaline phosphatase (ALP), aspartate aminotransferase (AST), and alanine aminotransferase (Farzaei *et al.*, 2018). These enzymes are crucial indicators for understanding the extend of liver damage condition. Reduction of the activity of above-mentioned enzymes might be beneficial in reversing the liver disorders.

Role of curcumin of modulation of liver diseases

In-vitro studies have reported that curcumin exhibited potential anti-oxidant and anti-inflammatory activity that might be beneficial for chronic liver diseases. Experiments conducted on animal models suggested protective role of curcumin in prevention of liver damage through anti-fibrogenic

functions and inhibition of progression towards liver damage. Curcumin resulted in modulating crucial signaling pathways in chronic liver disease. The hepatoprotective role of curcumin might be due to its potential anti-oxidant property and attenuation of inflammatory condition. Curcumin has also resulted mitigation acute and sub-acute injury of liver through reduction of serum aminotransferase enzymes and also by lowering the lipid peroxidation in liver. It has also been reported to activate various anti-oxidant enzymes including hepatic SOD, enhanced the GSH levels, attenuating liver lipids through modulating fatty acid and cholesterol bio-synthesis. These are the most highlighted pathways reported for hepatoprotective role of curcumin in the recent researches. The molecular mechanism of curcumin was also reported for its inhibitory action on NF-kB. It is a well-known transcription factor responsive to oxidative stress and inflammation. These conditions are in turn crucial in progression towards various liver diseases. Curcumin has been also utilized as potential in reducing liver cancers. The anti-oxidant ability of curcumin and potential role in the downregulation of TGF-β and NF-kB transcription factors has been reported as most significant mechanistic pathways against liver fibrosis and carcinogenesis (Vera *et al.*, 2013; Nabavi *et al.*, 2014).

Future prospects and concluding remark

The biological activity of curcumin in effective modulation of chronic liver diseases has been explored by various researchers. The most potent action of this micronutrient resulted from its anti-oxidant and anti-inflammatory activities. Studies should focus on the bioavailability of this component since it is very poorly absorbed upon oral administration. The chemical nature of this molecule was reported as hydro insoluble and a marked portion of ingested curcumin was not absorbed from the small intestinal lumen. Future studies could concentrate on enhancing the dosage, bioavailability, and effectiveness of curcumin by creating novel formulations and combining it with other substances. Before contemplating using supplements containing curcumin to treat liver issues, speaking with medical authorities must be taken into consideration. Studies are needed on bioavailability, toxicity of curcumin exploring the pharmacokinetics and pharmacodynamic potentials as well. The improved delivery system of curcumin through nano-particles might enhance the bioavailability. More studies confirming the therapeutic dose of curcumin for attenuating the chronic liver diseases must be conducted.

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Chapter - 8
Exploring the Applications of Lemon Seed Oil -A Comprehensive Review

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Chapter - 8

Exploring the Applications of Lemon Seed Oil -A Comprehensive Review

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Abstract

This article reveals the valuable information about the composition of bioactive compounds, aromatic substances, and sensory characteristics found in lemon seed oils. This paper was intended to uncover new possibilities for utilizing this relatively unexplored oil. Two different methods, cold pressing and hexane extraction were employed to extract oil from lemon seeds. A comparison was made between the physicochemical and thermal properties of hexane-extracted and cold-pressed oil samples. Cold pressing yielded a considerably lower oil quantity (36.84%) compared to hexane extraction (71.29%). Around 30 distinct aromatic volatile compounds were identified, with most concentrations being higher in the cold-pressed sample. Lemon seed oil exhibited a highly aromatic profile, featuring citrus, herbal, terpenic, woody, and floral aromas as its primary characteristics. In summary, this study concluded that the cold pressing method produces high-quality lemon seed oil, which, while not suitable for direct consumption, is valued for its unique aroma and bioactive components, making it suitable for various applications such as functional foods, pharmaceuticals, cosmetics, and to develop flavoured food product.

Keywords: Lemon seed oil, fatty acid composition, bioactive compounds, volatile compound

Introduction

Lemon seeds (Citrus Limon) are considered as an important source of plant oil, often produced as industrial waste product. Laboratory-scale extraction of lemon seed oils has revealed their physicochemical properties, fatty acid composition, sterols, tocopherols, and minor constituents. Vegetable oils, including lemon seed oil, are rich in bioactive compounds such as fatty acids, omega-3 fatty acids, tocopherols, tocotrienols, phytosterols, flavonoids, phenolic acids, pigments, and minerals. These compounds contribute to the

nutritional value and consumer preferences of natural oils. The oil can be obtained through various methods such as solvents, different types of presses, or using supercritical fluids. The main goals of these processes are to produce oil that is minimally damaged, free from impurities, economically viable, and generates minimal waste. Cold pressing has gained recent attention for its ability to produce specialty oils. It involves using safe, clean, high-quality oil-bearing materials, maintaining a maximum temperature of 40 degrees Celsius, and avoiding the use of chemicals or complex unit operations. Cold-pressed oils have specific characteristics, including the presence of tocols, sterols, phenolics, triterpene alcohols, hydrocarbons, flavor compounds, and other bioactive compounds. They do not undergo external formation of trans fatty acids due to the absence of heat and contain no preservatives. The study aims to compare cold-pressed and solvent-extracted lemon seed oils, particularly focusing on their flavonoid, phenolic acid, and pigment composition, as well as their volatile aromatic profiles. This characterization is intended to provide valuable data for potential applications of lemon seed oil in various industries, including food, cosmetics, pharmaceuticals, and chemicals. Overall, this article highlights the potential of lemon seed oil as a valuable resource with a range of bioactive compounds and explores different extraction methods and their applications.

Lemon seed oil Extractions

The lemon oil can be extracted using cold-pressing process or hexane-extraction. To briefly explain the process, the seed moisture content was adjusted to 12% before cold pressing. Hexane extraction of the seeds involved mixing ground seeds and hexane at a ratio of 1:2.5 (w/v) in a closed vessel. The mixture was shaken for 3 hours at 45 °C in a water bath (Thermal Electronics, Istanbul, Turkey), and this extraction process was repeated three times. It was observed that the cold-pressing technique yielded only 37% of oil, which was significantly lower compared to the 71% obtained through the solvent extraction process. However, there was no significant difference in the fatty acid composition between the two methods, with both oils containing quantifiable amounts of linoleic and palmitic acids as the major fatty acids.

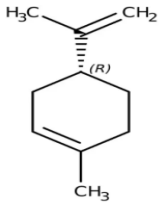
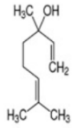
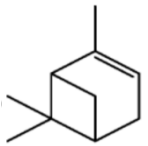
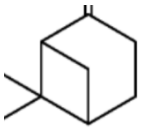
To ensure the removal of any remaining hexanes from the oil samples, nitrogen was flushed through them for 30 minutes at room temperature. All the oils produced were stored in amber-colored and capped glass containers, flushed with nitrogen, and kept frozen until analysis.

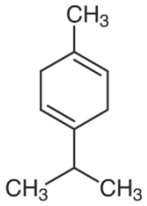
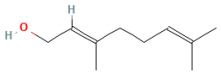
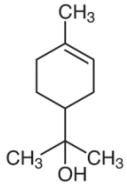
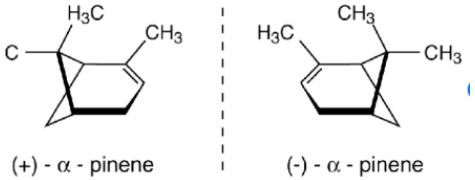
Quantification of Volatile Aromatic Compounds

The volatile compounds in the lemon seed oils were identified by the

methodology adapted from Krist *et al.*, 2006. To analyze these volatile compounds in the oil samples, the headspace solid phase microextraction (SPME) technique (Pawliszyn *et al.*, 2012) was employed (Yılmaz *et al.*, 2015, Yılmaz *et al.*, 2015). The identification of these volatile compounds involved comparing the mass spectra of unknown substances with those found in the National Institute of Standards and Technology (NIST, 2008) and the Wiley Registry of Mass Spectral Data databases (WILEY, 2005), and also utilizing the Retention (Kovats) index as a point of reference. The semi-quantification of these volatile compounds was carried out using the Total Ion Chromatogram (TIC) and calculated based on their relative abundances (Anwar *et al.*, 2008).

Table1: Components in lemon seed oil, structure and functions

Various components found in lemon seed oil with their structure	**Functions**
 **Limonene**	Responsible for its characteristic citrus aroma. Limonene also possesses antioxidant properties.
 **Linalool**	Present in small amounts, linalool adds floral and citrus notes to the scent of lemon seed oil and is known for its relaxing properties.
 **α-Pinene**	Another major constituent of lemon seed oil, α-pinene contributes to its scent and is known for its anti-inflammatory and antimicrobial properties
 **β-Pinene**	This compound is similar to α-pinene and also contributes to the aroma of lemon seed oil. It possesses potential antimicrobial and anti-inflammatory properties.

 **γ-Terpinene**	This is a minor component of lemon seed oil but contributes to its fragrance. It may also have antimicrobial properties.
 **Geraniol**	Found in trace amounts, geraniol adds a sweet, floral scent to lemon seed oil and may have antimicrobial properties
 **α-Terpineol**	This compound contributes to the floral notes in the aroma of lemon seed oil and may have antibacterial and antioxidant properties.
 **Sabinene (Cis and trans)**	Sabinene is a monoterpene found in lemon seed oil, contributing to its aroma and potentially providing antimicrobial benefits.
 **α-Pinene**	Another major constituent of lemon seed oil, α-pinene contributes to its scent and is known for its anti-inflammatory and antimicrobial properties.

Sensory Descriptive Analysis

Under the guidance of a panel moderator, the panelists carried out sensory evaluations of lemon seed oil by physically examining real oil samples (Aydeniz *et al.*, 2014, Yılmaz *et al.*, 2015, Yılmaz *et al.*, 2015, Bocco *et al.*, 1998). This process led to the identification and definition of 13 sensory terms, along with the establishment of standards for these terms for use in the testing. To measure their sensory assessments, a 15-cm scale was utilized, with the lowest value of 1.0 on the left side and the highest value of 15 on the right side. During the sensory analysis, the panelists received oil samples enclosed

in sealed glass containers, each labeled with a three-digit code. They were also provided with water, a slice of apple, unsalted crackers, and a container for spitting out samples if needed. The sensory tests were conducted in natural daylight conditions at room temperature and took place over multiple sessions held on consecutive days, with randomly selected samples. Duplicate tests were carried out for each batch of lemon seed oils produced. Composition of Flavonoids and Phenolic Acids

in the samples was determined through a series of analytical procedures. Lemon seed oil samples were initially prepared for analysis initially. The flavonoids and phenolic acids were extracted from the samples using appropriate solvents. The specific extraction process and solvents used would depend on the detailed methodology applied in the study. Standards of flavonoids and phenolic acids were used for comparison and quantification. These standards are reference compounds that assist in identifying and quantifying the respective compounds in the samples. Analytical techniques, such as High-Performance Liquid Chromatography (HPLC), were employed for the separation and quantification of flavonoids and phenolic acids.

Quantification: The amount of flavonoids and phenolic acids present in the samples was determined using calibration curves based on the standards and the peak areas observed in the chromatograms.

Identification: The identification of compounds was achieved by comparing their retention times and spectral characteristics, such as mass spectra, with established standards and databases. The study's results section will provide a comprehensive account of the specific flavonoids and phenolic acids found in lemon seed oil, along with their respective concentrations, offering valuable insights into the oil's bioactive components. The research has scrutinized and reported the composition of flavonoids and phenolic acids in both cold-pressed and hexane-extracted lemon seed oils. In total, the study quantified 8 flavonoids, including catechin, eriocitrin, rutin, naringin, naringenin, hesperidin, neohesperidin, and kaempherol, as well as 5 phenolic acids, which are gallic, syringic, ferulic, rosmarinic, and trans-2-hydrocinnamic acids, in both oil samples.

Discussion

Gallic acid, naringin and syringic acid were discovered in higher concentrations within the lemon seed oil obtained through cold pressing, as opposed to the oil extracted using solvents. On the other hand, the solvent-extracted oil had higher levels of kaempherol. The study also noted the absence of certain phenolic compounds in lemon seed oil, which are commonly found in other parts of lemon, bergamot, and citrus processing by-

products and waste materials. Furthermore, the research reported that the total phenolic content in lemon seed oil was quantified at 1196.71 milligrams of gallic acid equivalents (GAE) per kilogram of oil. It's important to highlight that although lemon seed oil lacked specific phenolic compounds, existing literature has documented their presence in other components of lemon, bergamot, and citrus processing by-products and waste materials.

Volatile Aromatic Composition

The volatile aromatic compositions of both cold-pressed and hexane-extracted lemon seed oils have been examined, revealing the presence of 30 different compounds in both samples. In the hexane-extracted sample, the quantity of hexane was also measured. Among the identified compounds, many exhibited higher concentrations in the cold-pressed sample. Notably, compounds like d-limonene, γ-terpinene, β-pinene, β-cymene, α-pinene, α-terpineol, and α-thujene displayed elevated concentrations in both samples. These compounds are typically present in fresh citrus, terpenic, woody, herbal, and minty aromas, indicating that lemon seed oils possess a strong aromatic quality.

When these results are compared to those from other oils, cold-pressed sunflower seed oil and poppy-seed oil also exhibited a high degree of aromatic complexity, with 77 and 75 distinct volatile compounds identified, respectively. Importantly, it was noted that the cold pressing method preserves more volatile compounds in the oil in contrast to solvent extraction. This conclusion is consistent with prior research that examined hot-pressed, cold-pressed, and solvent-extracted flaxseed oils, revealing 51 volatiles in hot-pressed, 47 in cold-pressed, and 40 in solvent-extracted oils. Collectively, these findings suggest that some volatile compounds are lost during the solvent extraction process.Nonetheless, it's important to exercise caution when assessing aromatic substances in food samples, as the concentration of these compounds does not necessarily dictate their prominence in the overall aroma or odor experience. Aroma chemistry recognizes that the perception of any aromatic molecule is associated with its aroma threshold value, which is the lowest concentration at which humans can detect it. Some compounds possess robust and noticeable aromas even at extremely low concentrations, while others require higher concentrations to be detected. Consequently, the distinct aroma of any food sample results from the cumulative impact of all the aromatic volatiles present. In summary, the 30 identified compounds collectively contribute to the perceived fragrance of lemon seed oil, which is predominantly characterized by citrus, terpenic, herbal, and floral notes (Malacrida *et al.*, 2012)

Conclusion

This research underscores the potential value in repurposing lemon seed waste, which could have economic ramifications for both lemon processors and oilseed and kernel processors. It emphasizes the significance of lemon seed oil as a valuable resource abundant in bioactive components and aromatic qualities. While it may not be suitable for direct consumption due to its bitterness, its potential applications in various industries make it a subject of interest for future studies and economic utilization.

Future scope

This study represents a valuable contribution to the existing literature by providing previously unavailable data on lemon seed oils. Key findings from the study include: Bioactive Constituents: The analysis quantified bioactive constituents in lemon seed oils, including various flavonoids and phenolic acids, as well as carotenoids and chlorophyll. Lemon seed oil has demonstrated significant aromatic qualities and an abundance of bioactive compounds, rendering it a potential option for incorporation into fresh food product recipes, as well as for applications in the pharmaceutical and cosmetic industries. Additional investigation is required to delve into its functional food attributes and potential clinical benefits.

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Chapter - 9
Insights of Beneficial Effects of Protein Bar Using Plant Based Foods: A Review

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Chapter - 9

Insights of Beneficial Effects of Protein Bar Using Plant Based Foods: A Review

Manideepa Mukherjee and Manisha Maity

Abstract

Protein bars are convenient, pre-packaged food products designed to provide a concentrated source of protein, typically in the form of whey, soy, casein, or plant-based proteins. They are rich in high-quality protein, which is essential for muscle repair and growth. They often contain additional ingredients such as nuts, seeds, dried fruits, whole grains, and sweeteners to enhance flavor, texture, and nutritional value. Protein bars are popular among athletes, fitness enthusiasts, and individuals seeking to support their protein intake, muscle recovery, and overall nutritional needs. They are commonly used as on-the-go snacks, meal replacements, or post-workout refueling options. Including protein bars as part of a balanced diet may help reduce overall calorie intake by keeping hunger at bay.

Several nutritious ingredients like chia seed, dates, nuts, micro-algae, soy, sunflower seed, pea protein, millet are used in formulation of protein bars. Those ingredients have several micronutrients, antioxidants like polyphenols, tocopherols, phenolic compounds. Phytochemicals, minerals like potassium, magnesium is also present in these type of protein bars. Micro-algae, pea protein, sunflower seeds those type of foods are also incorporated in the bars because of their higher nutrition level, cancer preventing properties, high protein content, gluten free alternatives. Despite their popularity, the quality and nutritional value of protein bars can vary widely depending on their formulation, ingredients, and processing methods. As such, there is a growing interest in developing protein bars that not only taste great but also deliver optimal nutrition to support various health and fitness goals.

Protein bars can be a convenient and effective way to support muscle health, weight management, and overall nutritional needs.

Keywords: Protein bar, antioxidants, nutrition, meal replacement, balanced diet, muscle health.

Introduction

People's eating habits have changed significantly as a result of the modern lifestyle. Rapid urbanization, the rise in popularity of eating healthily, and food efficiency have all had a significant influence on the growth of the market for meal replacement products worldwide. Foods referred to be "meal replacements", which include bars, snacks, drink powder, and soup alternatives, are frequently used in place of full meals (Szydlowska *et al*., 2020). Sports and physical activity are becoming more and more a part of today's lifestyle to support health. The body has to be protected from mechanical stress and the potentially harmful effects of free radicals, whose formation is boosted by physical activity and exercise and can result in macromolecule oxidative damage, after these activities. As a result, there is a growing market for goods like high-protein bars, which were first created to help sportsmen gain more muscle mass. These solutions save time in meal preparation by effectively replenishing nutrients and energy lost via physical activity (Jovanov *et al*., 2021).

An energy bar is essentially the same as a nutrition bar. It is described as a ready-to-eat, convenient food in the form of a bar that boosts energy and typically consists of fats, carbs, proteins, vitamins, and minerals as its main ingredients (Ayad *et al*., 2020). Youth are especially interested in protein bars among snack foods because of their potential for improved sports nutrition, health, and endurance. As a result, protein bars are quite popular for recreational activities including jogging, hiking, and muscle growth (Thakur *et al*., 2022).

All natural ingredients such as chia seed, Dates and Figs are packed with fructose and dextrose are used for the preparation of protein bar and are known to be a great energy booster. Another name of nuts is the powerhouse of goodness and sometimes they are also known as brain fruits such as cashew, walnut, almond. Most salient features of nuts are maintaining the blood pressure and good cholesterol level in our body. The presence of various seeds such as sesame, chia, flax seed aids to maintain the high nutritional profile and helps to restore proper body functions. One of the principal sources of protein, antioxidant, good cholesterol and fibre is seeds (Ansari *et al*., 2021).

Nuts, fruits, and cereals make up the perfect meal format for snack bars, which are multipurpose goods that are frequently produced to provide customers with dietary fiber, bioactive components, and beneficial nutrients (Constantin and Istrati, 2018).

In light of this view, the principle focus of this present work is to search and review the beneficial effects of plant-based protein bar.

Differents natural ingredient used in protein bars

Chia seed

Considered a functional food, chia (Salvia hispanica L.) is a grain that is high in fiber and includes nutrients that are good for your health. It is made up of the following: minerals, vitamins, ashes (4-5%), dietary fiber (18–30%), oils (30–33%), carbs (26-41%), protein (15–25%), and antioxidants like polyphenols, tocopherols, and phenolic compounds. Linoleic acid has very high level of poly unsaturated fatty acids. Among various plant sources, chia seeds contain a very high amount of □-linolenic fatty acids (Veggi *et al.*, 2018).

In addition to providing vitamins and minerals, chia seeds provide antioxidants that can be found naturally such kaempferol-6, quercetin, caffeic acid, phenolic glycosides-Q and K, chlorogenic acid and that guard against harmful situations like some cancers and cardiovascular illnesses (Sing *et al.*, 2020).

Dates

P. dactylifera, or date fruit, is one of the Arecaceae family's most significant crops. Date fruit's nutritional makeup is mostly made up of fiber, protein, and carbs, with very little fat. There are also good concentrations of micronutrients, which include various phytochemicals, minerals like potassium and magnesium, and vitamins like thiamine, riboflavin, C, and E. High-quality saturated and unsaturated fatty acids, including linoleic, and linolenic acids, oleic, lauric, palmitoleic, make up the fat content of date pits (Barakat and Alfheeaid., 2023).

Pregnant and nursing women can benefit greatly from date fruit. Potassium, which is abundant in dates, aids in preserving the electrolyte balance in expectant mothers' bodies when their blood volume increases throughout pregnancy. In addition, dates have iron, which helps avoid anemia, and calcium, which promotes the building of fetal bones (Ibrahim *et al*., 2021)

Nuts

In many parts of Asia and Africa, nuts are considered to be extremely nutritious and essential for human health. However, a significant amount of fat may be found in most nuts, such as pecans (70%), macadamia nuts (66%), Brazil nuts 65%, walnuts 60%, almonds 55%, and peanut butter 55%.Antioxidants come in a variety of forms in nuts. For instance, a variety of flavonoids, such as catechins, flavonols, and flavonones that occur in aglycone and glycoside forms, are found in almonds. Walnuts have a range of

polyphenols and tocopherols, while peanuts and pistachios are high in resveratrol and contain several flavonoids. Typically, walnut polyphenols are classified as non-flavonoid ellagitannins. It's likely that nuts can help with cardiovascular diseases in a number of ways (Blomhoff *et al*., 2006).

Microalgae

Single celled microalgae could be another enticing functional ingredient that can be used to prepare protein bar. The two species that are most frequently used as food additives are Arthrospira platensis, also marketed as Chlorella vulgaris and spirulina. They have all of the necessary amino acids and high-quality proteins (dry weight 65%). Microalgae typically create polysaccharides with a highly complicated structure that may have biological properties that prevent cancer. They also contain polyunsaturated fatty acids, pigments, sterols, phenolic compounds, vitamins, micro and macro minerals (Cu, Mn, Zn and Fe), and having antioxidant qualities (Fanari *et al*., 2023).

Soy

Foods high in protein and low in cholesterol include soy. It has a lot of proteins, vitamins, and minerals in addition to fiber. Soy protein bars, with their high protein content, offer many advantages to kids. Bioactive components found in soybeans include oligosaccharides, phytosterols, lecithin, isoflavones, and saponins. Many of these components are anti-cancer and antioxidant-rich. Because of its low cost and excellent nutritional value, soy protein has become the most popular commercially accessible vegetable protein worldwide, displacing animal-derived proteins in substantial amounts. Because soy foods have a high isoflavone content, they have been the focus of a lot of research. Isoflavones are also known as estrogen receptor modulators and plant estrogens (Khan *et al*.,2023).

Sunflower seed

After sunflower oil is extracted from seeds, sunflower meal yields sunflower protein isolate (SPI). The additional value of SPI is very high. SPI is secondary product.

Sunflower protein has an advantage over other proteins extracted from plant sources (such wheat, pea and soy) because of its high helianthinin content, which makes it low allergenic and easily digested (up to 95%), preventing heartburn, bloating, and upset stomach. It's a great antioxidant because it also contains a lot of chlorogenic acid. Sunflower protein snack bars were devoid of antinutrients, low in fats, low in moisture, and a decent source of protein (Baurina *et al*.,2021).

Pea protein

As peas (Pisum sativum L.) are high in protein, fiber, carbohydrates, vitamins, and minerals, they are one of the principal legumes that are consumed frequently. Pea protein is naturally devoid of dairy, soy, and gluten (Altooimi., 2015).

Pea protein is made from crushed yellow split peas and is frequently obtained by mechanically separating the proteins from soy and whey instead of chemically. Because of this, the pea protein is also able to preserve its soluble fiber content, which has numerous positive effects on digestive and cardiovascular health. Lysine, the building block of carnitine, which aids in converting fatty acids into energy, is abundant in peas. Additionally, lysine might support a strong immune system (Krefting., 2017).

Millet:

Pennisetum glaucum, or pearl millet, is seen as the crop of the future that will guarantee human nutritional security. Because of its high nutritional content, which includes high levels of riboflavin, magnesium, phosphorus, zinc, folic acid, and iron. Pearl millet is a good reservoir of various essential macronutrients. These are also containing huge amounts of dietary fibres mainly insoluble fibres. The presence of resistant starch is also noteworthy (Samuel and Peerkhan., 2020). To make protein bars, millets such as sorghum (Sorghum bicolor) and finger millet (Elusine coracana) were also utilized. Millets have special qualities, such as being gluten-free, a healthy source of carbohydrates, and high in phenolic compounds, minerals, and dietary fiber (Rajeesha *et al*., 2021).

Conclusion

The beneficial effects of plant- based protein bars underscore their potential to contribute significantly to health and wellness. Plant- based protein bars offer a diverse range of nutrients, including amino- acids, fiber, vitamins, minerals, and anti-oxidants making them a valuable addition to balanced diets.

Plant based protein bars are rich with health promoting factors that helps the consumers to have good energy value, muscle growth and bone health also give a healthy weight gain. Children to sport personal can intake the plant-based protein bars according to their health status.

By reducing reliance on animal-derived proteins and minimizing the ecological footprint, plant –based protein bars align with the growing emphasis on sustainable food choices.

In view of the upsurge in the demand for plant-based protein bars, the present article has discussed the beneficial effects of protein bar using plant-based foods.

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Chapter - 10
Anaemia Burning Problems for Pregnant Women a Days Also

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Chapter - 10

Anaemia Burning Problems for Pregnant Women a Days Also

Soumita Sinha and Jagannath Ghosh

Abstract

In India 57% of pregnant woman are suffering from Anaemia. Over-all India the second common cause of maternal death is Anaemia. Pregnancy induced Anaemia is basically seen in pregnant women when baby is in foetus. It is a serious health hazards concerns to both the mother and the unborn child. It can cause maternal exhaustion which is an increased risk of infection, and problems after childbirth. It is distinguished by decrease of sanguine fluid levels or less count of RBCs in blood. Low birth weight baby and preterm birth baby are possible outcomes of negatively impact of fetal development. Inadequate iron consumption, deficiency of vitamin B12, physiological variations in blood volume, and sometimes family history plays a vital role for the causes of pregnancy-induced anaemia. In order to minimize its outcomes on the health of the mother with the child, early detection through standard prenatal screening and suitable management techniques, like iron supplementation and dietary changes, are essential. Pre-eclampsia, miscarriage, gestational diabetes, hypertension, are the common complications of pregnancy.

Keywords: Anaemia, burning problems, pregnant women

Introduction

Pregnancy is the condition that describes the period when a foetus develops insides a women's womb or uterus. When a woman has menstrual cycle four weeks her pregnancy typically lasts for approximately 40 weeks or 280 days for conception. The mother body undergoes profound changes at this time affecting every organ system in order to support the developing foetus. It is a condition of having a developing embryo or foetus in the female, when an ovum is fertilized by a spermatozoon.

Anaemia is the most familiar nutritional insufficiency disorders which basically stirring conceiving women in a high range and also it is the familiar cause of maternal mortality in India which contributing to about 80% of maternal mortality generated by anaemia in South East Asia. In expectant

mother Anaemia remains the most unmanageable community health problems in the evolve countries (Adegke *et al*., 2003; World Health Organization, 2001). The term 'anaemia' refers to a condition when the bloods ability to carry oxygen is diminished, and is most commonly defined by a drop in haemoglobin concentration. According to estimates from The World Health Organization (WHO) Anaemia is indicated by a sanguine fluid level of less than 11.0g/dl, which is present in half of the pregnant woman worldwide. 20% of the total devoted deaths in India, are caused by anaemia making it the second cause of death (Govt. of India, 1995). Pregnant women had anaemia prevalence ranging from 30%-100% with significant regional differences (Toteja *et al*., 2006). According to WHO anaemia is consider as 'moderate' public health relevance when its incidence is between 20% or lower (Adegke *et al*., 2003). Conceiving induced Anaemia is linked to poor baby upshot, such as underweight, premature child birth and unexpected death. It is also linked with internal disability in children (Bentley ME, Griffiths PL 2003). Women who suffer from mild anaemia may feel exhausted and unable to perform well at work. Severe anaemia is linked with maternal and child death (The World Health Organization Iron deficiency anaemia assessment 2001; Bentley ME, Griffiths PL 2003). Pregnant women who are anaemic run the risk of having poor physical activity levels and increased maternal morbidity and mortality particularly if they have severe anaemia. Anaemia have been caused by the lack of folate, iron, Vitamin B12 and vitamin, intestinal parasitic infections, malaria, chronic illness.

Complications in Pregnancy

Most common complications of pregnancy are (Mohamed *et al*., 2016):

- High Blood Pressure (Hypertension)
- Gestational Diabetes
- Infections
- Pre-eclampsia
- Preterm baby
- Depression and Anxiety
- Pregnancy Loss/Miscarriage
- Stillbirth
- Nausea
- Vomiting

Therefore, some complications are also seen in these three phases of trimester during pregnancy.

First trimester

The first 12 weeks of pregnancy is known as the first trimester. Many changes in the mother body are noticed in the first trimester. Hormonal imbalance affects all organs in the body in this time (Babker and Gameel, 2014). In this phase the foetus became 7.5 cm in length. In this trimester some complications are:

a) Tiredness
b) Weight gain or loss
c) Headache
d) Mood swings
e) Enlarging breasts and darkening nipples and areolas.
f) Discomfited stomach, whether or not vomiting occurs (morning sickness)
g) Frequent urination
h) Constipation (trouble having bowel movements)
i) Aversion to or Cravings for certain foods

Second trimester

The 13 to 28 weeks of the pregnancy is known as second trimester. Early pregnancy is generally referred to be "Golden period" since many of unpleasant side symptoms such as nausea and exhausting. The size of abdomen will enlarge as the baby growth. Additionally, the woman will feel her baby start to move before this trimester is out. By the time the second trimester ends the embryo weighs 820 and 30 cm in length. In the second trimester the woman may have seen some complications that are (Babker and Gameel, 2014):

a) Stretch marks on thighs, or buttocks, abdomen, breasts.
b) Itches of the palms, and underparts of the feet and belly button.
c) A line is noticed on the skin from belly button to pubic hairline.
d) Moderate facial, finger, and ankle edema: also general aches including pain in groin, thigh, abdominal or back.
e) Darkening of nipple skin.
f) Darker skin patches, typically found on the cheekbones, forehead, nose, or upper Numb or tingling hands (carpal tunnel syndrome).

Third trimester

The 29 to 40 weeks of the pregnancy is known as third trimester. This is the time when the ultimate weight growth occurs, which is the great weight

gain experienced during the pregnancy. The embryo grows quickly, intensifying and increasing the frequents of movement (Mohamed *et al*., 2016). Many new body changes might be seen in the third trimester include:

a) Shortness of breath
b) Trouble sleeping
c) Protruding Belly button
d) Heartburn
e) The baby shifting lower in the abdomen
f) Facial, finger and ankle swelling.
g) Hemorrhoids
h) Contractions, which may indicate real or false labor
i) Tender breasts that may leak colostrum

Anaemia in pregnancy

Anaemia is a worldwide health hazards that affect together industrialized and evolve countries. Anaemia effects 1.62 billion people worldwide or 24.8% of the total and is more common among pregnant woman (74%) (Adegke *et al*., 2003). National Family Health Survey (NFHS-4) data indicates that 50.3% of Indians suffer from anaemia. In comparison to metropolitan area about 50% of the people live in rural areas (The World Health Organization, 2001). During the period of pregnancy anaemia is broadly effect on the immune of the mother and the baby, leading the cause of decrease birth weight, premature labour, and backward of brain, leading to increase birth and death rate (Govt. Of India, 1995). There are huge causes of anaemia such as multiple child birth, lack of spacing between child birth, and nutritional and iron induced anaemia is the most relevant type of anaemia in world (Toteja *et al*., 2006; Bentley and Griffiths, 2003). Many studies reported that anaemia in pregnancy give negative health effects on both the mother and the child. The maternal negative health issues include exhaustion, impaired immune system, poor work capability, higher risk of heart diseases, and death (Black *et al*., 2013; Mbule *et al*., 2013; Stevens *et al*., 2013). The negative health effects for the child include adverse outcomes of embryo, neonatal and childhood such as perinatal mortality, before birth, low birth weight (LBW) babies, stillbirth, early predelivery death and small for gestational age newborns (Jessani *et al*., 2021; Black *et al*., 2013; Mbule *et al*., 2013; Stevens *et al*., 2013). Maternal anaemia is also associated with behavioural abnormalities and neurodevelopmental disorders in the child (Wiegersma *et al*., 2019). Various studies also showed an association between anaemia and maternal death (Black *et al*., 2013; Shi *et*

al., 2022; Daru *et al*., 2018). Apart from maternal mortality, anaemia in pregnancy may result in decrease fetal growth, low birth weight (LBW), stillbirth, and predelivery death (Shi *et al*., 2022; Nair *et al*., 2016; Figueiredo *et al*., 2018; Finkelstein *et al*., 2020). The reasons include maternity at low age, lack of education, low monthly family income, low socio-economic status, inadequate antenatal care visits, lack in dietary intake of iron and folic acid, record of food insecurity, lack of adequate meals/ day, short spacing of multiple pregnancies, excessive bleeding during labour, etc. (Sinha *et al*., 2021; Tolentino and Friedman, 2007; Azhar *et al*., 2021; Gebre and Mulugeta, 2015).

Conclusion

Now a day anaemia is a serious communal health problem in India. Anaemia specifically anaemia in pregnancy is extremely common in women of worldwide particularly in developing countries. Anaemia during pregnancy has been considered harmful to the life of the mother along with the baby also. The government of India has built up different strategies to reduce the frequency of anaemia among expectant women in pregnancy. The strategies in pregnancy include screening for anaemia during the period of pregnancy and treatment implies a combination of iron and folic acid (FeFo) supplements. Fe supplements and care during pregnancy and late pregnancy are also recommended to reduce the risk of anaemia. Through the government of India implemented many types of strategies, knowledge of the risk factors and compliance of pregnant women are very much essential to reduce anaemia in pregnancy and its consequences. It is highly recommended that awareness and education programs regarding the regular input of iron and folic acid supplements, nutritious diet and iron rich foods regular antenatal care visits. Hygienic practices and awareness regarding the minimum gap between two pregnancies should be generated at grass root levels to avert anaemia in the expectant women.

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