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Development of Cookies using Garden Cress Seed *Lepidium Sativum L* and Evaluation of its Antioxidant Activities

Minaxi R. Prajapati[1], K.B. Kamaliya[2], D.H. Patel[3]

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Abstract

Bakery products are widely popular among population now days because of their taste and ease in availability. Among bakery products, cookies are commonly used in each house hold. Frequency of consuming bakery products especially cookies is huge compared with any other processed or packed food. Besides, the usefulness of readily available foods, heath of people also compromised day by day. Consumption of functional food can help in preventing harmful effect of processed food. That is why, the demand of processed food added with functional ingredient are increasing. Looking to this, an attempt was made to develop cookies using Garden Cress Seed. After developing cookies, sensory, nutritional and antioxidant activities were evaluated.

Keywords: Garden Cress Seed; Antioxidants; Degenerative diseases.

INTRODUCTION

Lifestyle changes have increased the demand of ready to serve food products. It has become a first choice of working women and people living in urban areas. Among ready to serve food, bakery products are very popular among all age groups. Cookies are one the widely consumed bakery products which is available in many flavors and shapes. It is a good source of carbohydrate, fat and protein, few vitamins and minerals. Primarily they are made up of refined wheat flour, sugar and fat. But one can easily replace the ingredients with highly nutritional food such as millet flour, seed powder, fruit pulp etc. This way the nutritional value of cookies can be enhanced. Garden cress seed belongs to Brassicaceae family and its scientific name is Lepidium sativum. Common names of Garden cress seed includes Common Cress (English), Halim (Bengali), Aseliyo (Gujrati), Chansur (Hindi), Allibija, Kapila (Kannada), Alian (Kashmiri) Asali (Malayalam), Ahaliva, Haliv (Marathi), Allivirai (Tamil) and Adityalu, Aadalu (Telugu).[1] As per scientific investigations, seed comprising of 80–85% endosperm, 12–17% seed coat and 2–3% embryo. Seed contain 25% protein, 14-24% lipids, 33-54% carbohydrates and 8% crude fiber.[3,7] Garden cress seed possess various pharmacological properties.[9] In traditional medicinal system, Garden cress seed have been widely used in treating number of disorders in India such as hypertension, diabetes

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and kidney diseases and in prevention of cancer, cardiovascular diseases and mild glycemia in diabetic patients.[2,6]

Diabetes and cancers are the major degenerative diseases which are life threatening. Dietary management is one of the best ways to treat such diseases. Foods rich in fiber and antioxidants can help to great extents once these diseases occur.

Keeping all these researches and reports in view, an attempt was made to develop Garden cress seed cookies.

Objectives

- To develop cookies by incorporating Garden Cress Seed.
- To standardize the process parameters of cookies based on sensory properties.
- To evaluate sensory score, nutritional and antioxidant activities of developed product.
- To estimate the physicochemical properties of flour and blends used for cookie preparation.
- To determine Physical, Textural properties and shelf life of developed product.

METHODOLOGY

Development of Cookies

In the process of developing cookies, first standard formula of cookies was gathered from the bakery expert. Initial trials were conducted with incorporation deferent levels of garden cress seed powder and other ingredients. Each ingredient was standardizing to optimize the formula of garden cress seed cookies (Table 1). After optimizing the formula, cookies incorporated with garden cress seed was evaluated for sensory quality by using composite scoring test (Table 2).

Nutritional Composition and Antioxidant capacity of Cookies

Nutritional composition of cookies was carried out using AOAC standard methods. For evaluation antioxidant activity of cookies, sample extraction was carried out. Methanol: Distilled water (80:20) was used as a solvent for the extraction of cookies. Cookies were ground with mortal pastel and 300 mg of ground powder was taken in 50 ml conical flask. Then 5 ml of solvent was added. The mixture then was shaken for 30 minutes using a mechanical shaker (NOVA) at 30 rpm. After shaking, the content of flask was centrifuged (REMI) at 3000 rpm for 10 minutes and supernants were collected in sugar tubes. Again 5 ml of the same solvent was added to flask and process was repeated. Both supernants were combined, filtered and volume was adjusted to 16.3 ml. The obtained extract was stored at -20°C and used to anylysed for their total antioxidant capacity two methods i.e. ABTS and DPPH.

Evaluation of antioxidant activity

DPPH Radical Scavenging Activity

For analyzing DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging capacity of cookies, 0.2 ml of extracted sample was taken and volume was made up to 1 ml with methanol. Then 3 ml of DPPH reagent (1 mM in methanol) were added. The content was mixed properly. It was incubated at 37°C for 20 minutes. After incubation the absorbance was measured 517 nm in a UV visible double beam spectrophotometer (Hitachi 22OS, Japan). For control, 3 ml of DPPH was added to 1.0 ml of methanol. For standard, known concentration of trolox (10-40 µg) was taken and volume was made up to 1 ml with methanol. Pure methanol was used as a blank and percent inhibition was calculated using the following formula: % inhibition = (Abs of control – Abs of sample)/Abs of control x 100[4].

Total Phenolic Compounds Estimation

For estimating total phenolic compounds, 0.05 ml sample extract was taken in a test tube and volume was made up to 1 ml with distilled water. To this, 1 ml each of folin-ciocalteau reagent diluted with water (1:2) and 35% Na_2CO_3 were added. The contents were incubated for 30 min at room temperature. 2 ml of distilled water was added and intensity of blue colour was recorded at 620 nm in UV visible double beam spectrophotometer (Hitachi 220S, Japan). Gallic acid of known concentration (5-20 mg) was used as standard.

TEAC Measurement by ABTS Method

The TEAC (Trolox equivalent antioxidant capacity) of sample extract was measured using the modified 2,2′-azinobis (3-ethylbenzothiazoline-6-sulfonic acid diammonium salt (ABTS) radical decolonization assay. This method was given by Re et al (1999). 7mmol/L ABTS stock solution was reacted with 2.45mmol/L potassium persulphate to prepare ABTS radical cation (ABTS+) and

incubated in the dark at room temperature for 12–16 h. The ABTS+ solution was diluted with 5mM PBS (Potassium phosphate buffered saline, pH 7.4) to an absorbance of 0.7 at 734 nm before use. For assay, 20 µl of extract was taken, volume was made up to 1 ml with ethanol and 3 ml of ABTS was added to it. The contents were vertexed for 10 seconds. The discoloration caused by reduction of the cation by antioxidant from the sample measured at 734 nm in a UV visible spectrophotometer (Hitachi 200S, Japan). 1.0 ml of ethanol was added to 3 ml of ABTS and used as a control. For Standard, known concentration of trolox (5-20 µg) was taken and the volume was made up to 3 ml with ethanol and thereafter all test tubes were treated in the same way as sample. Percent inhibition was calculated using the following formula: % inhibition = (Abs of control – Abs of sample)/ Abs of control x 100[8].

RESULT

Nutritional Composition

High ash content is associated with high minerals content. Results of nutritional composition reflected the same, cookies without seed contained 1.82 mg% ash whereas cookies incorporated with garden cress seed found high ash content i.e. 2.83 mg% (Table 3). Among minerals, garden cress seed is rich source of calcium and iron. Incorporation of seed enhances calcium and iron level significantly. Cookies without garden cress seed possessed 68.47 mg% calcium whereas cookies incorporated with garden cress seed possessed 90.04 mg% of calcium. Same pattern was seen in case of iron, iron level of control cookies was 3.61 mg% and cookies incorporated with seed were 9.02mg%. Similarly, protein and fiber content of developed cookies were higher i.e. 8.04g% and 3.14g% respectively. Results of nutritional composition shows that developed cookies have high minerals and protein content and low in carbohydrate content. Inclusion of such product in diet can surely help in maintaining overall health.

In vitro Antioxidant activity

ABTS & DPPH radical scavenging activity

Either DPPH• or ABTS• radical scavenging activity can be used to evaluated the antioxidant capacity of food products. Generally, the ABTS•+ free radical is commonly used when issues of solubility or interference arise and the use of DPPH• based assays becomes inappropriate. In the present study both radical scavenging activities was evaluated. The percent inhibition of developed cookies extracts was 69.19 and 81.23 for ABTS• and DPPH• radical respectively. FRAP assay was also used to evaluate the overall antioxidant capacity. Cookies incorporated with seed shown 157.54% inhibition and control shown 74.35% inhibition. Similar pattern was followed in case of total phenolic compounds. The total phenolic compound of developed cookies was 251.75 mg% whereas 139.37 mg% was observed in control (Table 4). Results of antioxidant activities, suggested that cookies incorporated with garden cress seed possessed good antioxidant activity and can be used in prevention of degenerative diseases.

Table 1: Final formula optimized for GCSP cookies

Ingredients	Quantity
Flour	90%
GCSP	10%
Sugar	10%
Salt	2%
Ammonium bi-carbonate	2%
Cumin seed	2%
Carom seed	2%
Oregano	2%
Red Chili flakes	2%
water	17.50%
Shortening	40%

Table 2: Average Sensory (Composite) Scores of cookies prepared by replacing Maida with different levels of Garden Cress Seed powder

Characteristics/ Product	Volume	Crust Character	Crumb Color	Crumb Texture	Taste and Aroma	Mouth Feel	Overall quality
0% GCSP	7.76^{a} ±0.15	8.23^{a} ±0.14	16.76^{a} ±0.28	24.21^{a} ±0.33	8.42^{a} ±0.13	8.38^{a} ±0.14	8.42^{a} ±0.13

table cont...

5% GCSP	7.76^{a} ±0.15	7.59^{b} ±0.15	15.14^{b} ±0.30	23.64^{a} ±0.38	8.07^{a} ±0.15	8.02^{a} ±0.15	7.97^{a} ±0.16
10% GCSP	**7.78^{a} ±0.14**	**7.64^{b} ±0.17**	**15.09^{b} ±0.33**	**23.92^{a} ±0.38**	**8.00^{a} ±0.19**	**7.88^{a} ±0.19**	**7.92^{a} ±0.20**
15% GCSP	7.26^{b} ±0.15	5.21^{c} ±0.19	12.57^{c} ±0.31	16.00^{b} ±0.75	5.33^{b} ±0.24	5.28^{b} ±0.23	4.92^{b} ±0.32
F Value	2.80	61.40	31.58	64.69	58.19	58.01	54.81
CV%	9.10	10.91	9.47	10.31	11.52	11.56	13.61

GCSP = Garden Cress Seed Powder

All the replacements are based on bakers' percentage.

Values are Mean ± SEM scores of a composite scoring test by a panel of 7 judges × 3 replication.

Means bearing the same superscript within the column do not differ significantly ($p \leq 0.05$) $^{**}p \leq 0.01$

Values in the parentheses indicate number of maximum score.

Table 3: Nutritional Composition of Control and Developed Cookies

Cookies	Moisture (g%)	Ash (g%)	Protein (g%)	Fat (g%)	Fiber (g%)	CHO (g%)	Calcium (mg%)	Iron (mg%)
Control	9.73	1.97	7.29	24.85	2.67	64.06	68.47	3.61
10%GCSP	9.49	3.13	8.99	28.38	3.45	54.88	90.04	9.02
t-value	0.72	9.04**	12.05**	11.85**	7.22**	38.63**	41.95**	23.87**
p-value	0.48	3.19×10-^{07}	8.84×10^{-09}	1.09×10^{-08}	2.14×10^{-06}	1.26×10^{-15}	4.01×10^{-16}	9.64×10^{-13}

Values are mean of 8 replication

All the data except moisture is reported on dry weight bases

Table 4: Antioxidant capacity of Developed Cookies

Cookies	ABTS (% inh)	DPPH (% inh)	FRAP (% inh)	Total Phenol (mg%
Control	35.84	50.16	74.35	139.37
10%GCSP	69.19	81.23	157.54	251.75
t-value	29.56**	18.60**	37.40**	16.25**
p-value	5.09×10-^{14}	2.86×10^{-11}	1.96×10^{-15}	1.74×10^{-10}

Values are mean of 8 replication

DISCUSSION

Numerous researches have been carried out to document the nutritional and functional properties of garden cress seed is rich source of minerals and possess functional properties. In present study, an attempt was made to incorporate garden cress seed in cookies which is widely used in each home. Cookies incorporated with garden cress seed shown a good nutritional and antioxidant profile. This study was conducted *in vitro* and further need to conduct *in vivo* study for more detail.

CONCLUSION

On the bases of present study, it can be concluded that, cookies incorporated with 10% garden cress seed powder had good sensory acceptance. Addition of garden cress seed powder has enhanced protein, calcium and iron level besides increasing antioxidant activity. Such cookies can be preferred as a snack for kids and elder people also without much altering sensory attributes.

REFERENCES

1. Anonymous. Ayurvedic Pharmacopoeia of India, Part-1,1st ed, The drug controller of India, Government of India, Ministry of health and family welfare development of Indian system of medicine and homeopathy, New Delhi civil lines, Delhi. 2001; 1:26.
2. Anonymous. The Wealth of Indian Raw Materials Publication and information Directorate, CSIR, New Delhi, 1972; 9:71-72.
3. Arkroyd WR, Gopalan C, Balasubramanian SC. Nutritive value of Indian Foods and the planning of satisfactory diets. Indian Council of Medical Research, N. Delhi, 1960, 64p.
4. Bran-Williams M. Cuvelier and Berset C. (1995). Use of free radical method to evaluate antioxidant activity. Lebensmittel Wissenschaft and Technology., 28: 25-30.
5. Dannehl D, Huyskens-Keil S, Wendorf D, Ulrichs C, Schmidt U. Influence of intermittent-direct-electric-current (IDC) on phytochemical compounds in garden cress during growth. Food Chem. 2012; 131:239-246.
6. Kirtkar KM, Basu BD. Indian medicinal Plants. 2005; I:174.
7. Mathews S, Singhal RS, Kulkarni PR. Some physicochemical properties of *Lepidium sativum* (Haliv) seed. Die Nahrung. 1993; 37:69-71.
8. Re N., Pellegrini A., Proteggente A., Pannala M., Yang and Rice Evans (1999). Antioxidant activity applying an improved ABTS radical cation decolorization assay. Free Radical Biology., 26:1231-1237.
9. Vohora SB, Khan MSY. Pharmacological studies on *Lepidium sativum* Linn. Indian J Physiol Pharmac. 1977; 21:118-120.

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Development of an Immune Booster Turmeric *Curcuma longa* Infused Mango Ginger *Curcuma amada roxb* Rice Paste

Ananya Anil Rao[1], Harshitha TR[2], Shraddha S Karichannavar[3], Rakesh Kumar K[4], Manasa R[5]

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Abstract

In India, specifically in the southern states, rice is one of the highly consumed staple foods. To reduce the cooking time, rice pastes have been profoundly innovated and are manufactured in quite a few industries. Rice paste, that is considered as Ready-To-Eat (RTE) food product can be instantly mixed with a bowl of rice and can be consumed without much of preparation and it don't require much cooking time. The aim is to formulate an instant, ready to eat Rice paste using fresh turmeric, mango ginger, apple pulp and spices. The study involved preparation of rice paste by varying the ratio of mango ginger and apple pulp. The sensory quality of the developed rice paste was then assessed, and the proximate composition of both the modified version and control was estimated for comparison, further cost calculation was carried out. Main ingredients such as apple pulp, mango ginger, turmeric and ginger were obtained locally at Mysore. Additional ingredients like spices, Oil, salt were also locally sourced. 9-point Hedonic scale was used for sensory analysis and standard A.O.A.C (2005) methods were applied for proximate analysis. Among the variations tested, considering cost as an attribute, MGRP2 emerged as the most preferred sample in terms of sensory evaluation, with superior nutritional aspects on par with the control and it was constituted with quite higher levels of fibre, protein, calcium and phosphorus than control. The study successful in developing an immune booster, RTE Mango Ginger Rice Paste (MGRP2) with superior nutritional profile characterized by higher protein, fibre, calcium and phosphorus than that of control.

Keywords: Mango Ginger; Apple Pulp; Rice Paste; Anti-inflammatory; Anti-oxidant.

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INTRODUCTION

Over the past two decades, Indian cuisine and lifestyle have undergone significant changes due to factors like economic liberalization, dual incomes, nuclear families, creative cooking methods, media proliferation, and shifting eating habits. With long work hours during the week and weekends spent outside with family, people now have limited time for cooking, leading to a growing reliance on prepared foods.[1] This increased demand for ready-to-eat (RTE) options has expanded the processed and packaged food sectors, offering a wide array of products such

as instant breakfast items, bakery goods, meats, and prepared vegetables. Additionally, there's a rising preference for vegetarian and vegan RTE meals, driven by ethical considerations and health awareness. Consumers actively research RTE brands to find products that align with their nutritional requirements and taste preferences.[2]

Mango ginger, scientifically known as (*Curcuma amada roxb)*, is a spice that thrives in tropical soils and is considered underutilized. Referred to as Mango Ginger in English, Karpuraharidra in Sanskrit, Amada in Bengali, Ambehaldi or MangaiShunti in Kannada, and Manga Inchi in Malayalam, it is native to Bengal but widely cultivated across India. Despite its morphological and phylogenetic similarities to ginger (*Zingiber officinale*), mango ginger boasts a unique mango like flavor, attributed in part to cis-ocimene, a volatile aromatic compound found in its essential oil.

In culinary applications, raw Mangoginger is prized for its exotic taste and finds use in pickles, curries, salads, and other dishes, particularly in peninsular India. Beyond its culinary allure, Mangoginger holds significant ethnobotanical importance. Traditionally, it has been employed in treating various ailments such as abdominal pain.[3-5]

Turmeric, derived from the (*Curcuma longa)* herb, is widely utilized as an herbal remedy across South Asia. It addresses various health concerns such as rheumatoid arthritis, uveitis, conjunctivitis, skin conditions and infections. Additionally, it aids in wound healing and supports liver function. Its medicinal properties extend to digestive issues like indigestion, flatulence, and abdominal discomfort. Turmeric's anti-inflammatory, antimicrobial, and carminative qualities make it effective for managing conditions such as colic and dyspepsia. Particularly beneficial for digestive health, turmeric targets intestinal disorders like inflammatory bowel disease and colon cancer.[6]

For the base ingredient, we used apple pulp. The reason behind using apple pulp is that, it is rich in polyphenols and dietary fibers and also bland in taste which does not alter the flavours.

For the development of rice paste initially we procured the apple and processed into pulp. For the large scale production, we can procure the apple pulp from Kashmir region which will cost less, making the product cost effective.

Objectives of the study

- Formulation of ready-to-eat (RTE) mango ginger rice paste by blending mango ginger and fresh turmeric into the recipe.
- Assessment of the sensory attributes of the newly developed rice paste.
- Determination of the nutritional composition of both the experimental variation and the control sample.
- Calculation of the production costs associated with manufacturing the RTE mango ginger rice paste.

Procurement of raw materials

The research took place at the Department of Food Processing and Engineering, JSS College of Arts, Commerce & Science in Mysore, with the objective of creating mango ginger rice paste. Locally sourced ingredients such as apple pulp, mango ginger, turmeric, and ginger were utilized in the study. Furthermore, supplementary components including red chili powder, pepper powder, coriander powder, salt, citric acid, mustard oil, sunflower oil, mustard seeds, cumin seeds, asafoetida, and curry leaves were also obtained from the local area in Mysore.

Formulation of the product

The rice paste formulation primarily consisted of apple pulp and mango ginger as key ingredients. By adjusting the proportions of mango ginger and apple pulp, a total of six different variants were developed to explore various compositions and their potential effects on the final product.

Table 1: Product formulation for preparation of Mango Ginger Rice

Ingredients (G)	Control	MGRP 1	MGRP 2	MGRP 3	MGRP 4	MGRP 5
Mango Ginger	_	15	30	45	60	75
Apple Pulp	75	60	45	30	15	-
Fresh Turmeric	2	2	2	2	2	2
Ginger	4	4	4	4	4	4
Chilly Powder	11	11	11	11	11	11

table cont....

Coriander	5	5	5	5	5	5
Pepper	3	3	3	3	3	3

Method of preparation

The fresh produce, like apple, mango ginger, turmeric rhizome and ginger were pre-processed. They were cleaned thoroughly, sorted, peeled, cut into required size, blanched, and were packed in aseptic conditions and further stored using freezing technique.

The Mango Ginger Rice Paste was prepared by sautéing the above-mentioned fresh produce in sunflower oil, followed by addition of spices and seasonings. The tempering is prepared and added at the end of the cooking process to enhance the overall flavour and increase the shelf life by using mustard oil.

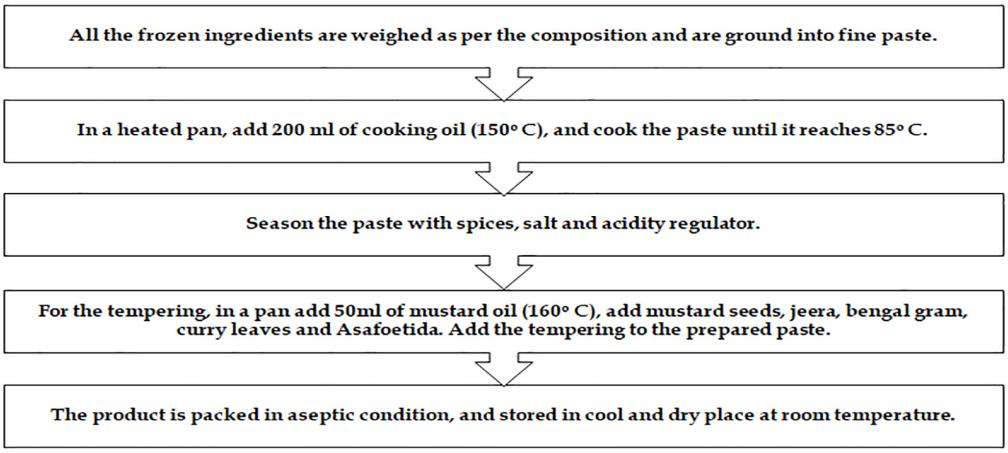

Fig. 1: Flow Chart of preparation of Mango Ginger Rice Paste (gm/100gm) Paste (gm/100gm).

Evaluation of organoleptic properties of Rice Paste

The developed product was subjected for the organoleptic properties using nine point hedonic scale which ranges from (0-9) by semi-trained panellists. All six formulations, including control were evaluated to consider for further analysis.[7]

Proximate analysis of Mango Ginger Rice Paste

The proximate analysis was conducted in triplicate using established A.O.A.C. (2005) methods. Crude fiber content was assessed using a Crude Fiber Analyzer. Carbohydrate content was calculated by subtracting the combined moisture, protein, fat, and ash content from 100 per 100g of the sample. Moisture content was determined using a hot air oven at temperatures ranging from 98 to 100°C, ash percentage was measured through high-temperature incineration (600°C) in a muffle furnace, and fat content was estimated using the Soxhlet apparatus. Energy values were computed using the formula: Energy value = Protein × 4 + Carbohydrate × 4 + Fat × 9.[8-11]

Fig. 2: Mango Ginger Rice Paste prepared from partial replacement of apple pulp with mango ginger in different proportions

Additionally, mineral analysis of iron and phosphorus was conducted using Atomic Absorption Spectrometry (AAS) due to its recognized accuracy and precision.[12]

Statistical analysis:

The data obtained from this study underwent statistical analysis using the Holm Sidak method to assess significance, with a predetermined level of $p \leq 0.05$. This approach allowed for rigorous examination of the results, ensuring robust conclusions regarding the impact of variables on the outcomes of the study.[13]

RESULT AND DISCUSSION

Sensory evaluation of Mango Ginger Rice Paste

The research aimed to develop Mango Ginger Rice Paste by substituting apple pulp with varying proportions of Mango Ginger (15%, 30%, 45%, 60%, 75%). Table 2 displays the impact of these substitutions on the sensory qualities of the Rice Paste. Results show that MGRP 1, MGRP 2, and MGRP 3 scored similarly to the control, indicating comparable sensory attributes. However, MGRP 4 and MGRP 5 received lower scores, suggesting they were less acceptable compared to the other variations.

Table 2: Sensory Evaluation of Mango Ginger Rice Paste, values are mean ± SD (n=30), p value ≤ 0.05

Variation	Appearance	Colour	Texture	Flavour	Taste	Overall
Control	7.17±0.80	7.29±0.91	7.11±1.05	7.05±1.08	7.32±0.93	7.11±1.36
MGRP 1	7.11±1.11	7.05±0.96	7.17±1.01	6.76±1.14	7.29±0.91	7.17±1.01
MGRP 2	8.01±0.61	7.88±0.92	7.88±0.85	7.82±1.01	7.17±0.95	7.94±0.82
MGRP 3	7.41±0.93	7.29±1.64	7.29±1.31	7.17±1.33	7.31±0.86	7.47±1.23
MGRP 4	6.64±1.05	6.17±0.80	6.76±0.97	6.52±1.17	7.29±0.98	6.58±1.22
MGRP 5	6.28±0.91	6.11±1.05	7.17±1.01	6.41±1.00	7.29±0.92	6.23±0.97

Proximate Composition of Mango Ginger Rice Paste

Table 3: Nutritional composition of Mango Ginger Rice Paste (30%) compared with control, values are mean ± SD (n=3), p value ≤ 0.05

Nutrients	Control	MGRP 2
Moisture (%)	31.34±0.29	30.42±0.18
Energy (Kcal)	102.26±0.16	95.81±0.13
Carbohydrate (g)	17.12±0.24	15.03±0.34
Protein (g)	2.69±0.06	3.04±0.10
Fat (g)	2.19±0.11	2.22±0.19
Total fibre (g)	8.85±0.04	9.65±0.09
Ash (g)	8.11±0.34	9.07±0.29
Calcium (mg)	31.28±0.09	35.66±0.11
Phosphorous (mg)	62.9±0.14	80.87±0.26
Iron (mg)	3.26±0.26	3.88±0.19

The proximate analysis was conducted to determine the composition of the accepted Mango Ginger Rice Paste (MGRP 2) and the control, and the results are displayed in Table 3. MGRP 2 showed higher values for protein, compared to the control, and fat remained same, whereas carbohydrate content was lower. Additionally, the fibre, ash, and other minerals such as calcium, phosphorous, iron and sodium content were higher in MGRP 2.

Cost analysis of Mango Ginger Rice Paste:

The total cost of producing MGRP2 amounts to Rs. 40 per 100g. This computation encompasses the combined expenses of procuring all ingredients from the market, as well as factoring in costs related to labor, gas, taxes, electricity, and packaging materials.

CONCLUSION

The study aimed to develop a Ready-to-Eat (RTE) Rice paste enriched with turmeric, ginger, mango ginger, and apple pulp, enhancing its nutritional value. Mango ginger, known for its mango like aroma, contributes to traditional medicine and adds a unique flavor dimension. Ginger's antioxidant properties and turmeric's antimicrobial benefits further enhance the product's health benefits. Additionally, the inclusion of apple pulp, rich in polyphenols and dietary fibers, boosts nutritional content without compromising taste. MGRP2 emerged as the favored variation, offering comparable nutritional benefits to the control at a cost-effective price point. This innovation addresses

Table Cont...

the demand for convenient, nutritious RTE options in regions where rice is a dietary staple, marking a significant advancement in culinary convenience and health consciousness.

REFERENCES

1. V Pradeepa, G Kavitha, a study on consumer behavior towards ready to eat food products in Coimbatore city, *journal of commerce and management thought* 4 (3), 599-611, (2013).
2. https://www.futuremarketinsights.com/reports/ready-to-eat-food-market.
3. [Dhanmaya Sharma, Sujata Upadhyay*, S. Manivannan, Karma DikiBhutia, Value addition and product diversification of mango ginger (Curcuma amada), *Journal of Postharvest Technology* 2023, 11(1): 66-76].
4. [Cheppail Ramachandran, Ivonne V. Lollett, Enrique Escalon, Karl-Werner Quirin, and Steven J. Melnick, Anticancer Potential and Mechanism of Action of Mango Ginger (Curcuma amadaRoxb.) Supercritical CO2 Extract in Human Glioblastoma Cells, *Journal of Evidence-Based Complementary & Alternative Medicine* 2015, Vol. 20(2) 109-119].
5. [Thirupathihalli Pandurangappa Krishna Murthy1,*, Balaraman Manohar, Grinding Studies of Mango Ginger: Mathematical Modelling of Particle Size Distribution and Energy Consumption, *American Journal of Food Science and Technology*, 2013, Vol. 1, No. 4, 70-76].
6. Mane RP, Kshirsagar RB, Sawate AR, Patil BM and Kale RG, Studies on evaluation of physicochemical and nutritional properties of fresh turmeric rhizome, *Journal of Pharmacognosy and Phytochemistry*, 2018; 7(2): 2895-2897.
7. Srilakshmi B. Food Science, Evaluation of Food Quality. *New Age International(P) Limited.* 2009;p. 297–8.
8. Solids (Total) and Moisture in Flour. 18th ed. AOAC International; 2005. p. 925.
9. AOAC. Association of Official Analytical Chemist. Washington DC, Method; 2005. p. 935.
10. Arora A, Sehgal P, Kawatra S, A. 962.09-Crude fibre analysis in feeds by filter bag technique-Official Methods of Analysis of the Association of AnalyticalChemists. vol. 481. North Frederick Avenue, Maryland; U.S; 2003. p. 20877–2417.
11. Aoac. Cereal grainsand forages; Randall/Soxhlet/ExtractionSubmersion method, Official Methods of Analysis of the Association of Analytical Chemists. In: Crude fat in Feeds. vol. 481; 2016. p. 20877–2417.
12. AOAC (2005) In: Official Methods of Analysis, 18th Edition, AOAC International, Gaithersburg.
13. Guo, W., & Romano, J. (2007). A Generalized Sidak-Holm Procedure and Control of Generalized Error Rates under Independence. *Statistical Applications in Genetics and Molecular Biology, 6*(1).

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Review Article

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To assess the Awareness of Pseudo-Cereals among Food and Nutrition Students of Indore City

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Abstract

Pseudo-cereals are a powerhouse of nutrients. There is a need to explore them further and bring them in our daily diet. Even though pseudo-cereals seem more superior than cereals in context of their chemical composition, the anti-nutrients present in them reduces the bioavailability of the nutritional components. As nutritional deficiency is becoming more prevalent among the human population throughout the globe, food producers are expected to develop novel strategies for their improved processing. The present study aims to assess the awareness of pseudo-cereals among food and nutrition students of Indore, with a focus on understanding their knowledge, perceptions, and potential gaps in awareness regarding these grains. The study included 200 subjects with age range (18-30) years, of colleges of Food and Nutrition of Indore (Madhya Pradesh). The assessment on awareness of pseudo-cereals among food and nutrition students was done based on their knowledge, perceptions, and potential gaps in awareness regarding these grains. The data was calculated by advance excel 2007 and statistical packaged tool. Results shows that there was statistically non-significant ($p>0.05$) difference between in the respondents on awareness and identification of pseudo-cereals.

Keywords: Pseudo-cereals; Chemical composition; Anti-nutrients; Protein content; Fiber content.

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INTRODUCTION

Cereals have been known to play a pivotal role to meet the demand of the human population since time immemorial. Cereals like corn, wheat and rice constitute approximately about 80% food consumption and are bio-fortified to improve the vitamin and other essential micro-nutrients. On the other hand, pseudo-cereals are naturally enriched with these essential micronutrients, but have not been explored for large scale production and consumption till date. Pseudo cereals are

dicotyledonous plants that are different from cereals in structure and function. In this context, Food and Agriculture Organization (FAO) has identified many plants as under utilized, which can significantly contribute for improving nutrition and health, enhance food basket and livelihoods, future food security and sustainable development. These underutilized crops offer an immense potential in the functional food sector to combat hidden hunger crisis and offer the options of income generation. Moreover, since underutilized crops are closely knit to cultural traditions and therefore are envisaged to have a role in supporting social diversity. However, now attention is turned from the underutilized crops and showing considerable interest in pseudo-cereals because of their high resiliency towards the abiotic stress, nutritional, and phytochemical potential and their usage in gluten free products. In near future, as the human population is predicted to rise, it will be needed to adopt an interdisciplinary approach to combat food crisis by not only improving the quality of available food by enrichment or biofortification but also by exploring other potential plants which are already enriched with required micronutrients which is an important aspect of food security.

Types of Pseudo-cereals

Under the term "pseudo-cereals" a group of dicotyledonous plants is summarized that produce starch rich grains that can be used similarly to the monocotyledonous cereals, although they differ regarding their botanical classification. The most common pseudocereals are amaranth, quinoa and buckwheat.

METHODOLOGY

The present study desires to assess the awareness of pseudo-cereals among food and nutrition students of Indore, with a focus on understanding their knowledge, perceptions, and potential gaps in awareness regarding these grains.

The study was carried out in colleges of Food and Nutrition of Indore (Madhya Pradesh) in order to achieve adequate number of the sample size for the study. The sample was collected in age group between 18-30 years. The sample size for this study was composed of 200 subjects. Students of Food and Nutrition from colleges (Shri Vaishnav Vidyapeeth Vishwavidyalaya, Devi Ahilya Vishwavidyalaya, Mata Jijabai Govt. PG Girls College and Government Maharani Laxmi Bai Girls PG College) of Indore were the study population for data collection. To collect data from the respondents, a self-administered questionnaire was created. The questionnaire comprised of details with nineteen questions related to knowledge, food habit and preference of pseudo cereals.

Data Analysis

The data was figured out by using an appropriate statistical tool using different processes of data analysis as per requirement.

Demographical data were calculated in percentage and for the results of awareness of pseudo-cereals among food and nutrition students, data were statistically analyzed by chi square. The p-value determines whether the relationship is significant or not. If the p-value is greater than 0.05, then the null hypothesis is retained: there is indeed no relationship exists between the variables, then no further interpretation is necessary. If the p-value is less than 0.05, then the null hypothesis is rejected, meaning that there is significant relationship between the two variables.

RESULT AND DISCUSSION

This study was carried out in colleges of Food and Nutrition of Indore (Madhya Pradesh) with a sample size of 200 subjects with age range (18-30) years. Information regarding their demographic profile, educational background and preference of pseudoceral were assessed using a pretested questionnaire. Age, Gender, and Academic level were the first step to determine the demographic profile. It is strongly correlated with educational background of subjects. The data revealed that in age group (18-24), 8 (11.76%) students selected wheat as a pseudo-cereal whereas 14 (20.58%) students selected oats as a pseudo-cereal, 16 (23.52%) selected quinoa as a pseudo-cereal, 13 (19.11%) selected barley as a pseudo-cereal and 17 (25%) selected ragi as a pseudo-cereal. In age group (25-30), 15 (11.36%) students selected wheat as a pseudo-cereal where as 20 (15.15%) students selected oats as a pseudo-cereal, 47 (35.60%) selected quinoa as a pseudo-cereal, 18 (13.63%) selected barley as a pseudo-cereal and 32 (24.24%) selected ragi as a pseudo-cereal.

Whereas, in age group (18-24), 57 students were aware of pseudo-cereal where as 11 were un-aware. In age group (25-30), 124 students were aware of pseudo-cereal whereas 8 were un-aware. In age group (18-24), 55 students considered

pseudo-cereal as a good source of protein where as 13 didn't. In age group (25-30), 123 students considered pseudo-cereal as a good source of protein whereas 9 didn't. In age group (18-24), 56 students considered pseudo-cereal as a good source of fiber whereas 12 didn't. In age group (25-30), 121 students considered pseudo-cereal as a good source of fiber whereas 12 didn't.

From college Shri Vaishnav Vidyapeeth Vishwavidyalaya, 10 students in age group (18-24) identified the picture as cereal and 16 as pseudo-cereal and in age group (25-30), 2 students identified the picture as cereal and 3 as pseudo-cereal Hence, the difference was not statistically significant ($p>0.05$). From college Devi Ahilya Vishwavidyalaya, 12 students in age group (18-24) identified the picture as cereal and 11 as pseudo-cereal and in age group (25-30), 1 student identified the picture as cereal and 3 as pseudo-cereal Hence, the difference was not statistically significant ($p>0.05$). From college Mata Jijabai Government Girls PG College, 14 students in age group (18-24) identified the picture as cereal and 17 as pseudo-cereal and in age group (25-30), 12 students identified the picture as cereal and 4 as pseudo-cereal Hence, the difference was not statistically significant ($p>0.05$). From college Government Maharani Laxmi Bai Girls PG College, 17 students in age group (18-24) identified the picture as cereal and 16 as pseudo-cereal and in age group (25-30), 8 students identified the picture as cereal and 2 as pseudo-cereal Hence, the difference was not statistically significant ($p>0.05$). From college Choithram College of Paramedical Sciences, 14 students in age group (18-24) identified the picture as cereal and 19 as pseudo-cereal and in age group (25-30), 11 students identified the picture as cereal and 8 as pseudo-cereal Hence, the difference was not statistically significant ($p>0.05$).

This result shows that there is awareness of pseudo cereals among the students of Food and Nutrition. It was found that the respondents have the awareness of pseudo-cereals based on fiber and protein content.

CONCLUSION

Pseudo-cereals are a powerhouse of nutrients. There is a need to explore them further and bring them in our daily diet. Even though pseudo-cereals seem more superior then cereals in context of their chemical composition, the anti-nutrients present in them reduces the bioavailability of the nutritional components. Phytate and lower inositol phosphates binds to the minerals like calcium, zinc, magnesium, and iron, making them unavailable for absorption. As nutritional deficiency is becoming more prevalent among the human population throughout the globe, food producers are expected to develop novel strategies for their improved processing. Moreover, there is a requirement of making people aware about the benefits of pseudo-cereals so that they consider them in their diet along with the cereals which will also elevate the nutritional quality of their diet.

Based on the findings of the study, it can be concluded that food and nutrition students possess a significant level of knowledge regarding the awareness of pseudocereals. The statistical analysis, with a p-value less than 0.05, indicates a strong association between the students' level of education in food and nutrition and their awareness of pseudocereals. This suggests that the curriculum or educational programs in food and nutrition effectively equip students with the necessary knowledge about pseudocereals. These results underscore the importance of continued education and training in food and nutrition to ensure that professionals in the field remain well informed about emerging trends and developments in food science.

REFERENCES

1. Tanveer Bilal Pirzadah, Bisma Malik, "Pseudocereals as super foods of 21st century: Recent technological interventions", 17 June 2020.
2. D. Morales, M. Miguel, M. Garcés-Rimón, "Pseudocereals: A novel source of biologically active peptides" Critical reviews in food science and nutrition, 61 (9) (2021), pp. 1537-1544.
3. RJ Fletcher, "Nutritional constituents of pseudo cereals and their potential use in food systems: A review" Trends in Food Science & Technology, 75 (2018), pp. 170-180.
4. FAO, The State of Food and Agriculture. Rome: Food and Agriculture Organization; 2013.
5. Pirzadah TB, Malik B, "Pseudocereals as super foods of 21st century: Recent technological interventions", Journal of Agriculture and Food Research. 2020.
6. Mir NA, Riar CS, Singh S. "Nutritional constituents of pseudo cereals and their potential use in food systems": A review. Trends in Food Science & Technology. 2018.
7. Bekkering CS, Tian L. "Thinking outside of the cereal box: Breeding underutilized (pseudo) cereals for improved human nutrition". Frontiers in Genetics. 2019.

8. Henrion M, Labat E, Lamothe L. "Pseudocereals as healthy grains: An overview. In: Innovative Processing Technologies for Healthy Grains": John Wiley & Sons Ltd.; 2021. pp. 37-59.
9. Padamnabhi Nagar, Riya Engineer and Krishna Rajput, "Review on Pseudo-Cereals of India", 28 November 2021, DOI: 10.5772/ intechopen.101834.
10. D. Bender and R. Schönlechner, "Recent developments and knowledge in pseudocereals including technological aspects", 20 Jul 2021, Pages: 583-609.
11. Haros, C.M and Schoenlechner R. (Eds.), "Pseudocereals, chemistry and technology", 2021, Wiley–Blackwell, pp. 163–192.
12. Samira Dakhili, Leyla Abdolalizadeh, Seyede Marzieh Hosseini, Saeedeh Shojaee-Aliabadi, Leila Mirmoghtadaie, "Quinoa protein: Composition, structure and functional properties", 9 July 2019, Food Chemistry Volume 299.
13. Priyanka Thakur, Krishan Kumar, Harcharan Singh Dhaliwal, "Nutritional facts, bio-active components and processing aspects of pseudocereals: A comprehensive review", 27 May 2021, Food Bioscience Volume 42.
14. L. Alvarez-Jubete, E.K. Arendt, E. Gallagher, "Nutritive value of pseudocereals and their increasing use as functional gluten-free ingredients" February 2010, Trends in Food Science & Technology Pages 106-113.
15. Samira Dakhili, Leyla Abdolalizadeh, Seyede Marzieh Hosseini, Saeedeh Shojaee-Aliabadi, Leila Mirmoghtadaie "Quinoa protein: Composition, structure and functional properties", 30 November 2019, Food Chemistry Volume 299.
16. Aluwi, N.A., Murphy, K.M., and Ganjyal, G.M. (2017). Physicochemical characterization of different varieties of quinoa. Cereal Chemistry, 94(5): 847–856.
17. Priyanka Thakur, Krishan Kumar "Nutritional importance and processing aspects of pseudo-cereals", 2019, Journal of Agricultural Engineering and Food Technology, 155-160.
18. Ritu Sindhu, B. S. Khatkar, "Pseudocereals: Nutritional Composition, Functional Properties, and Food Applications", 2019, Food Bioactives.

Review Article

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The Potential of Nutraceuticals for Age Related Macular Degeneration (AMD)

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Abstract

Age related macular degeneration (AMD) is a serious threat to public health as it is the leading cause of visual loss, and its prevalence is predicted to rise considerably. While current treatment options exist for advanced stages, there is a compelling need to explore preventative and management strategies. This review investigates the potential of nutraceuticals in mitigating AMD progression. We explore the proposed mechanisms of action by which specific nutraceuticals may counteract oxidative stress, inflammation, and other detrimental factors. The Age Related Eye Disease Study (AREDS) and AREDS2 are two important clinical research studies that are looked at to show how certain formulations with antioxidants and minerals can help people. Furthermore, we delve into emerging evidence on the potential of promising This review underscores the potential of nutraceuticals as a complementary approach for managing AMD, emphasising the need for further research to optimise their efficacy and personalise treatment plans for individual patients.

Keywords: Age-related macular degeneration (AMD); Nutraceuticals; Lutein; Zeaxanthin; Oxidative stress; Inflammation.

INTRODUCTION

AMD is a devastating eye disease that affects the macula, a critical area of the retina crucial for precise central vision.[1–5] It is a significant cause of blindness, especially among the elderly, and affects millions of people worldwide.[1] The gradual pattern of vision loss makes observing and managing AMD difficult.[6–11]

A. Types of AMD

There are two primary subtypes of AMD categorised based on their underlying pathology, severity, and clinical presentation: "wet" (neovascular or exudative) and "dry" (atrophic) AMD.[2,8,12] While they share some characteristics, dry AMD progresses more gradually and can ultimately lead to blindness.[2] The location, size, and number of drusen are crucial indicators of AMD severity and potential vision loss.[3]

B. Challenges and Need for Nutritional Intervention

Unfortunately, previous research hasn't established optimal dosages or specific nutrient combinations for treating AMD and other eye

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conditions.[4] Many patients, seeking relief, resort to over-the-counter supplements without proper guidance.[4] This highlights the critical need for scientific and medical expertise to inform patients and consumers about potentially beneficial dietary strategies.[13–18]

C. Focus of this Review

This review focuses on the well-studied dietary approach for treating and preventing AMD and other eye-related disorders. In this article, researchers discuss the potential benefits of a number of different nutrients, such as zinc, selenium, anthocyanins, and vitamins A, C, and E.[12–20] Among these, zeaxanthin and lutein stand out as potent antioxidants with the potential to lower the risk of AMD and other eye diseases.[5] Vitamins C and E also play a role, while vitamin A holds particular importance for the human retinal pigment epithelium.[5,8]

Types of Macular Degeneration

AMD, also referred to as macular degeneration, affects the macula, which is the central region of the retina and crucial for precise central vision.[1] Apparently, dry AMD and wet AMD are the two main classifications that are used for describing AMD.[1,20]

A. Dry AMD (Non-neovascular AMD)

Approximately 80–90% of all instances of macular degeneration have dry AMD. Thus, this renders dry AMD the most prevalent form of macular degeneration.[2] It is considered a gradual deterioration of macular tissue as the cells in the macula degenerate over time.[2] Deposits known as drusen, composed of yellowish extracellular material, often accumulate behind the retina in dry AMD.[2,8] Dry AMD typically progresses slowly and can lead to a progressive decline in central vision.[20] Recent clinical trials that focused on complement system modulators have shown negative results, which suggests that therapy may not be able to help at this point.[3] These failures may be attributed to similar reasons as observed in other degenerative diseases of the degenerative diseases of the central nervous system. Treatment may be initiated too late in the disease cascade, after a point of no return has been reached. There are currently no known tactics to prevent additional photoreceptor loss along the borders of the atrophic areas in the macula. In such circumstances, irreversible damage has already occurred to neural tissue, particularly retinal photoreceptors. This causes the retina to progressively lose its ability to perceive light.[3]

B. Wet AMD (Neovascular AMD)

Wet AMD, constituting 10–15% of all AMD cases, is less common but presents a more severe form of the disease.[2] These aberrant blood vessels are fragile and prone to bleeding, further exacerbating vision loss through scar tissue formation.[2] Wet AMD can manifest with sudden changes in vision, including distortion or a black spot in the centre of the visual field.[2] Wet age-related macular degeneration can rapidly proceed and result in permanent visual loss if it is not addressed.[2] Over the past several years, there has probably been a major rise in the number of people who are blind or have serious vision impairments. Data from Germany and other countries reveal that despite a discernible increase in the frequency of AMD, rates of blindness and severe visual impairment have remained consistent or even decreased.[4,8] This is the case, despite the fact that the prevalence of AMD has increased. This pattern is most certainly attributable, at least in a significant degree, to the effective launch of a treatment in 2005 for the most severe form of age-related macular degeneration, which is known as exudative late type.[4,20] This recognition was based on the findings of two successful phase 3 clinical studies. Intravitreal injections are where anti-VEGF medications are given to patients. These injections are given directly into the vitreous body of the eye. Ranibizumab, which was authorised in 2007, aflibercept, which was approved in 2012, brolucizumab, which will be approved in 2020, and bevacizumab, which has been used off-label since 2005, are the four medications that are now accessible for commercial usage with these characteristics.[4,8]

C. Causes and Risk Factors

Age-Related Macular Degeneration (AMD): Risk Factors

- **Chronological Ageing:** The most prominent risk factor for AMD is advancing age.[1] The macula, a region of the retina with high metabolic activity, places a significant cumulative burden on the retinal pigment epithelium (RPE) for waste product clearance throughout life.[1] With senescence (cellular ageing), the RPE's capacity for phagocytosis (waste removal) diminishes, potentially contributing to AMD pathogenesis.[1]
- **Smoking:** A modifiable risk factor, cigarette smoking significantly increases the risk of developing AMD.[1] Compared to non-smokers, smokers exhibit elevated risk ratios ranging from 2.6 to 4.8.[1] Notably, even smoking cessation does not entirely eliminate

the risk, with former smokers having a 1.7-fold higher risk than those who never smoked.[1]

- **Genetic Predisposition:** Recent research has identified several genetic polymorphisms associated with AMD susceptibility, including those linked to smoking behavior.[1] Changes in the complement factor H (CFH) and age-related maculopathy susceptibility 2 (ARMS2) genes are especially important because they may explain up to 45% of the overall risk of AMD.[1]
- **Potential Associations with Other Conditions:** Studies suggest possible correlations between AMD and various health conditions, including:
  - Body mass index (BMI)[1,10]
  - Cardiovascular disease (CVD)[1,20]
  - Arterial hypertension (high blood pressure)[1,20]
- **AMD and Atherosclerosis: A Tentative Link** Research investigating the potential connection between AMD and atherosclerosis (arterial wall thickening) yields inconclusive results, but some intriguing similarities exist.[2,4] Drusen, hallmark deposits found in AMD, share certain characteristics with atherosclerotic plaques observed in the arteries of individuals with high cardiovascular risk.[2,4]

Nutraceuticals and Amd

Nutraceuticals, a blend of "nutrition" and "pharmaceutical," encompass food or food components with potential health benefits. They offer a natural and potentially complementary approach to managing AMD.[8,20]

A. **Mechanisms of Action:**

Several methods have been proposed to explain how nutraceuticals may assist AMD sufferers.

- **Antioxidant Effects:** AMD is linked to oxidative stress, which damages retinal cells. Nutraceuticals having antioxidant characteristics, such as vitamins C and E and carotenoids (lutein and zeaxanthin), may help neutralise free radicals and preserve retinal tissue.[8,19]
- **Anti-inflammatory effects:** Chronic inflammation is linked to AMD development. Anti-inflammatory nutraceuticals such as omega-3 fatty acids and curcumin may aid in reducing inflammation and protecting retinal cells.[8,19]
- **Modulating Cell Signalling Pathways:** Certain nutraceuticals, such as zinc and vitamins, may impact cellular signalling pathways that contribute to AMD progression.[8,19]

B. **Clinical Evidence**

- **The Age-Related Eye Disease Study (AREDS) and AREDS 2:** Landmark studies showed that certain nutraceutical formulations with high doses of antioxidant vitamins (C and E) and zinc greatly lower the risk of progressing to advanced AMD in people who already have intermediate or advanced AMD in one eye.[8,13,19]
- **Lutein and Zeaxanthin:** Recent studies suggest a potential preventive role for carotenoids in age related macular degeneration (AMD) due to their high macular concentration and capacity for blue light filtration.[8,13,19]
- **Other Nutraceuticals:** Another investigation is being carried out on nutraceuticals like omega-3 fatty acids and coenzyme Q10 to determine their specific function in managing AMD. However, additional studies are required to demonstrate their conclusive impact.

Key Dietary Factors Associated with Nutraceuticals in the Context of Macular Degeneration Include

Antioxidants: Dietary antioxidants play a crucial role in protecting the retinal pigment epithelium (RPE) from oxidative stress, a well-established contributor to the pathogenesis of age related macular degeneration (AMD).[1] Nutraceuticals enriched with antioxidants, particularly vitamins C and E, zinc, and selenium, possess the potential to neutralise free radicals and minimise oxidative damage within the macula.[5,8,13,19]

Omega-3 Fatty Acids: The omega-3 fatty acids docosahexaenoic acid (DHA) and eicosatetraenoic acid (EPA) are particularly abundant in fatty fish like salmon and trout, which are considered to be among the best sources of oil. It has been suggested that these fatty acids may have positive effects on eye health, including the reduction of inflammation and the maintenance of the structure of the retina.[8,13,19,20]

Lutein and Zeaxanthin: A. Lutein and zeaxanthin are carotenoids that are found in leafy green foods such as spinach and kale. These carotenoids concentrate in the retina, particularly in the macula.

By functioning as antioxidants and assisting in the filtering of potentially hazardous high-energy light waves, these chemicals have been speculated to have a role in the prevention of macular degeneration.[8,13,19]

Vitamins: Micronutrients such as vitamins A, C, and E play essential roles in maintaining overall ocular health. Vitamin A, in particular, is critical for optimal retinal function.[8,13,19]

Zinc: Maintaining adequate zinc homeostasis is crucial for retinal health. Studies have investigated zinc supplementation as a potential intervention to slow the progression of age-related macular degeneration (AMD).[8,13,19]

Age-Related Macular Degeneration: The Role of Supplementation and Diet

AMD, particularly the dry form, remains a significant challenge for ophthalmologists and researchers.[1] Despite numerous clinical trials, there is currently no known cure for this progressive retinal disease.[1] However, modifiable factors like diet and supplementation can significantly impact AMD incidence and progression.[2,8,13,19]

Table 5. 1. Nutrient Composition of Commercially Available Formulas Based on the Age-Related Eye Disease Study (AREDS/AREDS2)

Nutrient	AREDS Formula (Age-Related Eye Disease Study)	AREDS2 Formula (Age-Related Eye Disease Study 2)
Vitamin C	500 mg	500 mg
Vitamin E	400 IU	400 IU
β-Carotene	15 mg	Not Included
Lutein	Not Included	10 mg
Zeaxanthin	Not Included	2 mg
Zinc	80 mg	80 mg
Copper	2 mg	2 mg

Sources: National Eye Institute. (n.d.). Facts about age-related macular degeneration. National Institutes of Health (gov): https://www.ncbi.nlm.nih.gov/books/NBK560778/.8

Dietary Considerations for Amd

Diet is undeniably a vital factor in AMD management.[2] Appropriate nutritional counselling is recommended for individuals at risk.[2] Here are some key dietary principles:

Improve Diet Quality: Dietary Recommendations for Age-Related Macular Degeneration (AMD): Age related macular degeneration (AMD) is a leading cause of vision loss in older adults. While there is no cure, a well-balanced diet rich in certain fruits, vegetables, and whole grains can play a significant role in managing AMD and potentially slowing its progression. Here's a breakdown of key dietary recommendations:

Prioritise Fruits and Vegetables: Consume a rainbow of fruits and vegetables throughout the day to benefit from a wide range of antioxidants and other protective nutrients.

Leafy greens are champions. Focus on dark leafy greens like spinach, kale, and collard greens, which are rich in lutein and zeaxanthin, carotenoids crucial for macular health.[1]

Other beneficial choices: Include orange and yellow vegetables like carrots, peppers, and sweet potatoes, as well as berries and citrus fruits, all rich in vitamins and antioxidants.

Embrace Whole Grains: Choose whole grains over refined grains. Whole grains provide fibre, which can help with overall health and potentially reduce inflammation, a factor in AMD development.[2]

Examples: brown rice, quinoa, whole wheat bread and pasta, and oats.

Limit pro-oxidative foods:

Minimise saturated and trans fats. These fats can contribute to inflammation, potentially worsening AMD.

Reduce processed foods: Limit processed foods, sugary drinks, and excessive red meat, as these may contribute to oxidative stress.

Additional Considerations

Prioritize Retinal Nutrients: Increase consumption of foods rich in lutein, zeaxanthin, omega-3 fatty acids, vitamins C and E, and zinc.[2] Examples include leafy green vegetables, eggs, fatty fish, and nuts.[9,13,19]

Limit Pro-Oxidative Foods: Reduce intake of processed foods, saturated and trans fats, and refined carbohydrates, which can contribute to oxidative stress.[20]

Growing need for dialysis intervention

It is anticipated that the number of AMD sufferers will dramatically increase as the population of the world continues to age.[10] Healthcare professionals can play a proactive role by promoting dietary choices that minimise AMD risk and empower patients to manage this sight threatening condition.[10]

Considerations and Future Directions

Individualised Approach: The optimal nutraceutical combination may vary depending on an individual's specific needs and risk factors.

Safety and Dosage: A. High dosages of nutraceuticals may cause negative effects. Medical professionals should be consulted for dosage and drug interactions.

Future Research: More research is needed to explore the efficacy of various nutraceuticals, identify optimal formulations, and understand long-term safety profiles.

CONCLUSION

Certain dietary supplements have been shown to help manage AMD in clinical trials. The current AMD supplement includes antioxidants, zinc, and macular pigment carotenoids. However, further investigation is needed to optimise the dosage and combination of nutrients within the AREDS2 formula, ensure long-term safety and efficacy data, explore emerging micronutrients like omega-3 fatty acids and resveratrol, and develop personalised medicine approaches. New research directions include exploring the role of gut microbiota in AMD development and understanding gene-nutrient interactions that influence AMD risk and response to supplementation. Further research is needed to fully understand these potential benefits.

REFERENCES

1. Ambati, B. K., & Fowler, B. J. (2012). Mechanisms of age-related macular degeneration: The role of oxidative stress. Survey of Ophthalmology, 57(4), 265-283. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7866075/
2. Datta, S., Manejwala, M., & Chakravarthy, U. (2017). Age-related macular degeneration. Indian Journal of Ophthalmology, 65(12), 1588-1595. https://www.ncbi.nlm.nih.gov/books/NBK560778/
3. Pinelli, R., & Bertelli, M. (n.d.). Drusen and age-related macular degeneration. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8077017/
4. McCarty, M. F. (2000). A review of nutritional factors in the pathogenesis and treatment of age-related macular degeneration. Archives of Ophthalmology, 118(12), 1618-1630. https://pubmed.ncbi.nlm.nih.gov/35695158/
5. National Eye Institute. (n.d.). Facts about Age-Related Macular Degeneration. National Institutes of Health (.gov). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4322741/
6. Mitchell, P., et al. (2018). Age-related macular degeneration. Lancet, 392(10153), 1150-1172.
7. Seddon, J. M., et al. (2004). Recommendations on dietary intake of lutein and zeaxanthin in the context of age-related macular degeneration. Archives of Ophthalmology, 122(5), 490-495. https://pubmed.ncbi.nlm.nih.gov/21899805/
8. National Eye Institute. (n.d.). Facts about age-related macular degeneration. National Institutes of Health (.gov) https://www.nih.gov/about-nih/what-we-do.
9. Hammond Jr, B. R., et al. (2013). American Academy of Ophthalmology preferred practice pattern on carotenoids, antioxidants, and age-related macular degeneration (2013 update). Ophthalmology, 120(8), 1630-1641.
10. Bryl A, Falkowski M, Zorena K, Mrugacz M. The Role of Resveratrol in Eye Diseases-A Review of the Literature. Nutrients. 2022 Jul 20;14(14):2974. doi: 10.3390/nu14142974. PMID: 35889930; PMCID: PMC9317487.
11. Huang, H. C., et al. (2014). Genetic variants associated with age-related macular degeneration and dietary factors: The Beaver Dam Eye Study. Ophthalmology, 121(7), 1424-1433.
12. Ostrowski, J., Kątska-Ostrowska, K., Gruszecki, W., & Rejdak, R. (2020). Diet and supplements as a supportive treatment for age-related macular degeneration. *Ophthalmology Journal*, *5*, 100-105.
13. Pawaskar, L., Sharma, A., & Kiran, M. (2023). A comparative study in the Indian patients of geographic atrophy for the efficacy and safety for the AREDS 2 Formula, the combination of Vitamin C, Copper, Zeaxanthin, Zinc, Lutein, and Vitamin E, with the combination of L-Glutathione, Lutein (contains Zeaxanthin) and Astaxanthin. *Indian Journal of Clinical and Experimental Ophthalmology*, *10*(4), 555-560.
14. Fernandes, N., Araújo, M. C., & Lança, C. (2023). The Roles of Vitamin D and Polyphenols in the Management of Age-Related Macular Degeneration: A Narrative Review. *Future Pharmacology*, *3*(1), 317-328.
15. Koçyiğit, E., Gövez, N. E., Arslan, S., & Ağagündüz, D. (2024). A Narrative Review on Dietary Components & Patterns and Age-Related Macular Degeneration. *Nutrition Research Reviews*, 1-79.
16. Rondanelli, M., Gasparri, C., Riva, A., Petrangolini, G., Barrile, G. C., Cavioni, A., ... & Perna, S. (2023). Diet and ideal food pyramid to prevent or support the treatment of diabetic retinopathy, age-related macular degeneration, and cataracts. *Frontiers in Medicine*, *10*, 1168560.

17. Broadhead, G. K., Agrón, E., Peprah, D., Keenan, T. D., Lawler, T. P., Mares, J., ... & AREDS/AREDS2 Investigators. (2023). Association of dietary nitrate and a Mediterranean diet with age-related macular degeneration among US adults: The Age-Related Eye Disease Study (AREDS) and AREDS2. *JAMA ophthalmology*, *141*(2), 130-139.

18. Parker, J. (2023). ACNEM fellow article: AMD-age related macular degeneration adjunctive treatment modalities. *Journal of the Australasian College of Nutritional and Environmental Medicine*, *42*(4), 90-103.

19. Semenova, Y., & Bjørklund, G. (2023). Antioxidants and neurodegenerative eye disease. *Critical Reviews in Food Science and Nutrition*, 1-19.

20. Kushwah, N., Bora, K., Maurya, M., Pavlovich, M. C., & Chen, J. (2023). Oxidative stress and antioxidants in age-related macular degeneration. Antioxidants, 12(7), 1379.

Review Article

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Exploring Protease Inhibitors and Plant Protein Digestibility: Implications for Nutrition and Health

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Abstract

The significance of soya beans in animal feed and human nutrition has prompted extensive research into their protease inhibitors, particularly due to their impact on digestion and growth inhibition. Despite initial assumptions linking trypsin inhibitors to poor nutritive value, understanding their precise role has proven complex. This article presents a comprehensive review of plant based protein digestibility, focusing on factors influencing bioavailability and the effects of protease inhibitors such as Bowman-Birk and Kunitz-type inhibitors. Drawing from recent literature, it explores the mechanisms underlying growth inhibition and pancreatic hypertrophy, shedding light on the dynamic interplay between protease inhibitors and digestive physiology. Additionally, it discusses the broader implications for human health and the potential of protease inhibitors in shaping plant centric dietary patterns. Through a synthesis of experimental findings, this review provides valuable insights into the intricate relationship between protease inhibitors and plant protein digestibility, offering guidance for future research and dietary practices.

Keywords: Plant based proteins; Digestibility; Protein inhibitors; Bowman-Birk inhibitors; Kunitz-type inhibitors; Human nutrition; Bioavailability; Systematic review.

INTRODUCTION

In the realm of nutrition, the quest for sustainable and health-conscious dietary choices has led to a burgeoning interest in plant based proteins. Central to this discourse is the digestibility of plant proteins, a multifaceted aspect influenced by various factors including protease inhibitors. Among these inhibitors, Bowman-Birk and Kunitz-type inhibitors have garnered particular attention for their potential impact on digestive processes. Despite decades of research, understanding the precise mechanisms underlying their effects remains a challenge. Early investigations suggested a straight forward link between protease inhibitors and diminished nutritive value, yet subsequent studies have revealed a far more intricate relationship. This article aims to provide a comprehensive exploration of plant based protein digestibility, drawing on recent literature to unravel the complexities surrounding protease inhibitors and

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their interactions within the digestive system. By synthesizing insights from diverse sources, this study seeks to offer a nuanced understanding of the dynamic interplay between protease inhibitors and bioavailability, with implications for both research and dietary practice in the burgeoning field of plant centric nutrition.

The important role the soya bean has assumed in feeding animals and its potential contribution to the human diet, it is understandable why the protease inhibitors from that plant have received the most attention.[1] It was not long after soya beans were first introduced into the United States, primarily as a source of oil, the significant observation that soya beans had to be heated to support the growth of rats. With the discovery of a heat-labile inhibitor of trypsin and the demonstration of its ability to inhibit the growth of animals, it was generally assumed that the trypsin inhibitor was largely responsible for the poor nutritive value of raw soya beans.[2]

Plant-derived protease inhibitors, such as Bowman-Birk inhibitors and Kunitz type inhibitors, have been recommended to negatively affect alimentary protein digestion by obstructive the activity of trypsin and chymotrypsin in the human digestive system. As long as the complex interactions affecting the digestibility and bioavailability of plant proteins remain elusive, protease inhibitor supplements for beleaguered purposes could be a respectable option to take benefit of the scientifically proven advantageous effects of these compounds.

This research article provides a thorough examination of the digestibility of plant based proteins, addressing the growing interest in plant centric diets. The study systematically reviews existing literature to consolidate insights into the digestibility of various plant proteins and explores factors influencing their bioavailability.[3] This comprehensive review contributes valuable insights into the dynamic field of plant based protein digestibility, offering a nuanced understanding of factors influencing bioavailability. The findings aim to inform both researchers and individuals seeking to make informed choices about plant centric dietary patterns.

METHODOLOGY

This article adopts a narrative review approach, sourcing literature from reputable electronic databases such as NCBI, Google Scholar, ResearchGate, and PubMed. Publications spanning the last decade and written in English were considered for inclusion. Thematic synthesis was employed to analyze and organize the literature, facilitating a comprehensive examination of the topic.

RESULTS AND DISCUSSION

Although the most logical explanation for the growth inhibition evoked by the trypsin inhibitor would be the fact that it interfered with the normal digestive reactions in the intestinal tract, the true explanation has not proved to be that simple.[4] For example, adding the soya bean trypsin inhibitor to a diet containing predigested protein still led to an inhibition of growth, thus ruling out inhibition of intestinal proteolysis as being directly responsible for growth inhibition.[5] Perhaps the most significant observation that has ultimately led to a better understanding of the mode of action of the trypsin inhibitor was the finding that rats and chicks fed raw soya beans or purified preparations of the inhibitor developed an enlarged pancreas resulting in an increased secretion of pancreatic enzymes.

According to Clemente et al. (2019), the growth depression caused by the trypsin inhibitor might be the consequence of an endogenous loss of essential amino acids produced by the hypersecretory activity of the pancreas.[5] Since pancreatic enzymes are particularly rich in sulfur containing amino acids, pancreatic hypertrophy serves to divert the supply of these amino acids from the synthesis of body tissue to the synthesis of pancreatic enzymes which are irretrievably lost by excretion.[6] This loss in the Sulfur-containing amino acids accentuates an already critical situation concerning soya bean protein which is inherently deficient in these amino acids.[7] It is not surprising, therefore, that methionine supplementation will effectively counteract much of the growth depression caused by raw soya beans despite the persistence of pancreatic hypertrophy.

The mechanism whereby the trypsin inhibitor causes pancreatic hypertrophy is still not fully understood. Srikanth & Chen have suggested that the degree of pancreatic secretion is determined by the level of free trypsin present at any given time in the intestine.[6] As the level of trypsin drops below a certain threshold level, the pancreas is induced to produce more enzymes, and conversely, when the level of trypsin is restored to normal levels, the secretory activity of the pancreas is inhibited.[7] The agent directly responsible for these effects is believed to be the pancreas stimulating hormone, cholecystokinin (CCK), whose release from the

intestinal mucosa is inhibited by free trypsin. It is obvious from these considerations that any set of circumstances that leads to a reduction of free trypsin in the intestines, such as complexation with an inhibitor, will serve to release CCK resulting in a hyperactive pancreas.[7]

Other factors affecting the digestibility of protein

If the trypsin inhibitor is indeed the major factor responsible for the poor growth of animals fed on raw soya beans, then it should be possible to reduce the nutritive value of heated soya beans to that of raw soya beans by adding the same level of antitrypsin activity to heated soya beans as is present in the raw product. That this is not the case was demonstrated several years ago. Furthermore, an examination of varieties of soya beans revealed the absence of any correlation between trypsin inhibitor activity and PER, although PER and the size of the pancreas were significantly related inversely.[8] It would appear, therefore, that there must be present in raw soya beans some other factor, totally unrelated to the trypsin inhibitor, which is also causing pancreatic hypertrophy as well as inhibition of growth. This situation was clarified when it was found that the removal of protease inhibitors from unheated soya bean extracts by affinity chromatography on Sepharose bound trypsin produced only a 40% improvement in growth and reduction in the size of the pancreas compared to heat treatment.[10]

The above findings raise the question as to what is responsible for the remaining 60% of the growth retarding and pancreatic hypertrophic effects of raw soya beans. A comparison of the in vitro digestibility of raw soya bean protein from which the protease inhibitors had been removed by affinity chromatography with a heat treated control revealed that the latter was more readily digested by trypsin. This observation suggests that native soya bean protein is in itself resistant to digestion by trypsin unless denatured by heat. A related observation is the fact that the isolated globular proteins of Phaseolus vulgaris are also very resistant to attack by proteolytic enzymes. If undenatured protein is capable of binding trypsin by forming an enzyme substrate complex, as suggested by Karpińska & Czauderna (2022), this could also serve to remove the feedback inhibition of pancreatic secretion by trypsin and thus cause hypertrophy of the pancreas.[8]

Another factor that may influence the digestibility of the proteins of legumes is the lectins, have shown the lectin of black beans can reduce the digestibility of dietary protein presumably by interfering with the ability of the intestinal mucosal cells to absorb nutrients.[11]

Physiological significance in humans

It should be appreciated that most of the experiments dealing with the nutritional effects of the protease inhibitors have involved the use of the rat or the chick. What can be said about the relevance of such experiments to the human diet which may contain plant proteins as a potential carrier of these inhibitors.[12]

Many of the soya bean products intended for human consumption are manufactured from protein isolates which, depending on their mode of preparation, may contain as much as 30% of the inhibitor activity of the original raw bean. An examination of the trypsin inhibitor activity of several textured meat analogs reveals that, although the protein isolate from which they were made may be rich in antitrypsin activity, the final products generally contain less than 10% of the activity of raw soya bean flour. Churel has likewise shown that the heat treatment involved in the processing and sterilization of infant soya bean formulas reduced the trypsin inhibitor activity to less than 10% of the activity of the original isolate. This residual activity did not produce any weight reduction or pancreatic hypertrophy in rats. These observations are consistent with the findings, of Zeng et al. (2020) who found no pancreatic hypertrophy in rats fed soya bean flour in which only 54% of the trypsin inhibitory activity had been destroyed. Although a further enhancement in growth is produced when more of the inhibitor is destroyed, this can be attributed to an increase in protein digestibility per se rather than to further destruction of the inhibitor.[13]

Assuming for the moment that processing conditions may have been inadequate to reduce the level of trypsin inhibitor activity below that of the threshold level established for rats, would this activity still pose a risk to human health.[14] Human trypsin is known to exist in two forms, a cationic species, which is the major component of human pancreatic juice, and an anionic species, which comprises about 10 to 20% of the total trypsin activity. While the latter is fully inactivated by the soya bean inhibitor, the predominant cationic species is only weakly inhibited.[15]

In further support of the probability that the soya bean inhibitor is relatively ineffective against human trypsin is the rather interesting relationship

that appears to exist between the size of the pancreas of various species of animals and their sensitivity to pancreatic hypertrophy induced by raw soya beans or the inhibitor.[17] The pancreas of those species of animals whose weight exceeds 0.3% of their body weight becomes hypertrophic when fed raw soya beans, whereas those whose weights are below this value are insensitive to this effect. Since a man has a pancreas that is 0.09 to 0.12% of his body weight, one would predict that the human pancreas would be insensitive to the effects of the soya bean trypsin inhibitor.[8]

Role of trypsin inhibitors in other legumes

To what extent the protease inhibitors account for the poor nutritive value of plants other than soya beans is difficult to assess. Inhibitors that have been purified from the lima bean and peanut are capable of inhibiting the growth of rats whereas those isolated from Dolichos lablab and maize do not. Nevertheless, it may be significant to note that the trypsin inhibitors of many legumes are quite rich in cystine, and, may account for about 30 to 40% of the total cystine content of some bean proteins. It is conceivable, therefore, that a dietary loss of cystine from the inhibitor itself could contribute in a significant fashion to the poor nutritive value of these legumes in their native unheated state. Vagadia et al. (2018) have indeed shown that the cystine of the unheated navy bean protease inhibitor is only approximately 45% available to the chick compared to 76% available for the heat inactivated inhibitor.[11] Thus the protease inhibitors of some legumes may be a double edged sword; they not only reduce the digestibility of the protein and cause pancreatic hypertrophy but may also 'lockin' a significant fraction of the total cysteine content of the protein which is already limiting in the S-containing amino acids.[18]

It has been recognized for many years that the nutritive value and protein digestibility of many plant proteins, particularly those derived from legumes, are very poor unless subjected to cooking or some other form of heat treatment.[8] This beneficial effect of heat has been generally attributed, at least in part, to the destruction of a unique class of proteins that can combine in a very specific fashion with the enzymes (trypsin and chymotrypsin) that play a key role in the digestion of proteins in the intestinal tract of animals.[19] Elucidation of the precise manner in which these so-called protease inhibitors lead to growth inhibition, however, has proved to be more elusive than might be suggested by this simple concept. The situation is further complicated by the fact that factors other than protease inhibitors may affect the digestibility of dietary proteins. Interest in the nutritional role of protease inhibitors has continued to mount largely as a consequence of the recent introduction of texturized vegetable proteins as a possible substitute for meat protein in the human diet.

CONCLUSION

The study underscores the intricate dynamics surrounding plant based protein digestibility, particularly concerning the role of protease inhibitors like Bowman-Birk and Kunitz type inhibitors. While initial assumptions linked these inhibitors to poor nutritive value, their exact mechanisms remain elusive. Through a thorough review of recent literature, this study elucidates the complex interplay between protease inhibitors and digestive physiology, shedding light on factors influencing bioavailability and growth inhibition. Moreover, it explores the broader implications for human health and the evolving landscape of plant-centric dietary patterns. By synthesizing experimental findings and highlighting areas for further research, this review contributes valuable insights to our understanding of plant protein digestibility, offering guidance for both researchers and individuals navigating dietary choices.

REFERENCES

1. Rizzo G. 2020. The Antioxidant Role of Soy and Soy Foods in Human Health. Antioxidants (Basel, Switzerland), 9(7), 635. https://doi.org/10.3390/antiox9070635
2. Mangena P. 2022. Pleiotropic effects of recombinant protease inhibitors in plants. Frontiers in plant science, 13, 994710. https://doi.org/10.3389/fpls.2022.994710
3. Clemente, M., Corigliano, M. G., Pariani, S. A., Sánchez-López, E. F., Sander, V. A., & Ramos-Duarte, V. A. 2019. Plant Serine Protease Inhibitors: Biotechnology Application in Agriculture and Molecular Farming. International journal of molecular sciences, 20(6), 1345. https://doi.org/10.3390/ijms20061345
4. Kårlund, A., Paukkonen, I., Gómez-Gallego, C., & Kolehmainen, M. 2021. Intestinal Exposure to Food-Derived Protease Inhibitors: Digestion Physiology- and Gut Health-Related Effects. Healthcare (Basel, Switzerland), 9(8), 1002. https://doi.org/10.3390/healthcare9081002

5. Clemente, A., Arques, M. C., Dalmais, M., Le Signor, C., Chinoy, C., Olias, R., Rayner, T., Isaac, P. G., Lawson, D. M., Bendahmane, A., & Domoney, C. 2015. Eliminating anti-nutritional plant food proteins: the case of seed protease inhibitors in pea. PloS one, 10(8), e0134634. https://doi.org/10.1371/journal.pone.0134634.
6. Srikanth, S., & Chen, Z. (2016). Plant Protease Inhibitors in Therapeutics-Focus on Cancer Therapy. Frontiers in pharmacology, 7, 470. https://doi.org/10.3389/fphar.2016.00470.
7. Miller LJ, Harikumar KG, Wootten D, Sexton PM. 2021. Roles of Cholecystokinin in the Nutritional Continuum. Physiology and Potential Therapeutics. Front Endocrinol (Lausanne). 2;12:684656. doi: 10.3389/fendo.2021.684656. PMID: 34149622; PMCID: PMC8206557.
8. Karpińska, M., & Czauderna, M. (2022). Pancreas-Its Functions, Disorders, and Physiological Impact on the Mammals' Organism. Frontiers in physiology, 13, 807632. https://doi.org/10.3389/fphys.2022.807632.
9. Zeng, Q., Ou, L., Wang, W., & Guo, D. Y. (2020). Gastrin, Cholecystokinin, Signaling, and Biological Activities in Cellular Processes. Frontiers in endocrinology, 11, 112. https://doi.org/10.3389/fendo.2020.00112.
10. Islam, M. R., Ihenacho, K., Park, J. W., & Islam, I. S. (2019). Plasmid DNA nicking- a Novel Activity of Soybean Trypsin Inhibitor and Bovine Aprotinin. Scientific reports, 9(1), 11596. https://doi.org/10.1038/s41598-019-48068-6.
11. Vagadia, B. H., Vanga, S. K., Singh, A., Gariepy, Y., & Raghavan, V. (2018). Comparison of Conventional and Microwave Treatment on Soymilk for Inactivation of Trypsin Inhibitors and In Vitro Protein Digestibility. Foods (Basel, Switzerland), 7(1), 6. https://doi.org/10.3390/foods7010006.
12. Kuenz, S., Thurner, S., Hoffmann, D., Kraft, K., Wiltafsky-Martin, M., Damme, K., Windisch, W., & Brugger, D. (2022). Effects of gradual differences in trypsin inhibitor activity on the estimation of digestible amino acids in soybean expellers for broiler chickens. Poultry science, 101(4), 101740. https://doi.org/10.1016/j.psj.2022.101740.
13. Hemetsberger, F., Hauser, T., Domig, K. J., Kneifel, W., & Schedle, K. (2021). Interaction of Soybean Varieties and Heat Treatments and Its Effect on Growth Performance and Nutrient Digestibility in Broiler Chickens. Animals : an open access journal from MDPI, 11(9), 2668. https://doi.org/10.3390/ani11092668.
14. Cristina Oliveira de Lima, V., Piuvezam, G., Leal Lima Maciel, B., &Heloneida de Araújo Morais, A. 2019. Trypsin inhibitors: promising candidate satietogenic proteins as a complementary treatment for obesity and metabolic disorders? Journal of enzyme inhibition and medicinal chemistry, 34(1), 405–419. https://doi.org/10.1080/14756366.2018.1542387.
15. Choi, W. C., Parr, T., & Lim, Y. S. 2019. The impact of four processing methods on trypsin-, chymotrypsin- and alpha-amylase inhibitors present in underutilized legumes. Journal of food science and technology, 56(1), 281–289. https://doi.org/10.1007/s13197-018-3488-0.
16. Kumar, I & Gautam, M. (2021) Study of qualitative aspects for deteriorating nutritional status of rural households in Banda and Kannauj districts of Uttar Pradesh. *IJFANS*. ISSN: 2319-1775; eISSN: 2320-7876. Vol.10, Iss.2, Jun- 2021 www.ijfans.org.
17. Matias, L. L. R., Costa, R. O. A., Passos, T. S., Queiroz, J. L. C., Serquiz, A. C., Maciel, B. L. L., Santos, P. P. A., Camillo, C. S., Gonçalves, C., Amado, I. R., Pastrana, L., &Morais, A. H. A. 2019. Tamarind Trypsin Inhibitor in Chiatosan-Whey Protein Nanoparticles Reduces Fasting Blood Glucose Levels without Compromising Insulinemia: A Preclinical Study. Nutrients, 11(11), 2770. https://doi.org/10.3390/nu11112770.
18. Chauhan A & Kumar I. (2024) Opportunities & challenges of usage of bioactive compounds in agro-food businesses: a narrative review. *Sustainability, Agri, Food and Environmental Research*. ISSN: 0719-3726, 12(X), 2024:http://dx.doi.org/10.7770/safer-V12N1-art702.
19. Hertzler SR, Lieblein-Boff JC, Weiler M, Allgeier C. Plant Proteins: Assessing Their Nutritional Quality and Effects on Health and Physical Function. Nutrients. 2020 Nov 30;12(12):3704. doi: 10.3390/nu12123704. PMID: 33266120; PMCID: PMC7760812.

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Dietary Fiber Intake during Pregnancy and its Effects on Maternal and Newborn Health

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Abstract

Dietary fiber is an important component of a healthy diet, and adequate intake during pregnancy provides a variety of benefits to both mothers and their developing babies. This review examines recent research on the positive effects of consuming a fiber-rich diet during pregnancy. The current study shows how increased fiber intake can improve gastrointestinal function, promote regularity and reduce constipation, a common complaint of pregnancy. Additionally, the current study discusses the potential role of fiber in regulating blood sugar levels and aiding weight management, both of which are important for maternal health. Finally, the review examines the study and the possible relationship between increased fiber consumption and improved pregnancy outcomes, including reduced risk of gestational diabetes and premature birth. The current study also touches on the potential impact of maternal fiber intake on the developing gut microbiome of the newborn and its impact on long-term health.

Keywords: Dietary fiber; Pregnancy; Gastrointestinal function; Blood sugar regulation; Weight management; Pregnancy outcomes and Infants; Newborn health.

INTRODUCTION

Pregnancy brings important physical changes for women. A balanced and healthy diet is vital for both fetal and maternal health. Dietary fiber, a complex carbohydrate found in plant based foods like fruits, vegetables, whole grains, and legumes, is an essential component of a nutritious pregnancy diet that is often overlooked. A balanced and healthy diet is essential throughout life, but it is especially important during pregnancy. The growing fetus depends on the mother's food for growth and development, which affects everything from organ formation to brain functioning. Consuming a variety of food ensures that a woman gets sufficient vitamins, minerals and other essential nutrients for a successful pregnancy.[1] Dietary fiber is an often overlooked but important component of a healthy diet during pregnancy. Fruits, vegetables, whole grains and legumes all contain fiber, which is essential for digestion and intestinal health. However, many women do not eat enough fiber to meet the recommended daily requirement.[2] This review explores the growing amount of data on the benefits of dietary fiber for maternal and neonatal

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health. By investigating the favorable effects on both the mother and the growing infant, we are able to note the importance of including adequate amounts of fiber in the prenatal diet.

Importance of Dietary Fiber

Dietary fiber, often called roughage, is a plant based component that our bodies cannot fully digest. Despite this, fiber plays an important role in maintaining overall health.[1] There are two main types of dietary fiber, each with their own unique benefits:

A. Soluble Fiber: Soluble fiber dissolves in water, creating a gel like substance in the digestive system. This gel offers many health benefits, including:

- *Slowing down digestion:* By forming a gel, soluble fiber slows down the emptying of the stomach, promoting a feeling of satiety and potentially reducing overeating.[2]
- *Blood sugar control:* By slowing the absorption of glucose (sugar) into the bloodstream, soluble fiber may also help control blood sugar levels.[3]
- *Lowering cholesterol:* Soluble fiber can bind cholesterol in the digestive tract, promoting its excretion and potentially reducing levels of LDL ("bad") cholesterol.[4]

B. Insoluble Fiber: Unlike its soluble counterpart, insoluble fiber does not dissolve in water. However, it still plays an important role in digestion:

- *Adding bulk:* Insoluble fiber acts like a broom in the digestive tract, adding bulk to stool and promoting regular bowel movements.[5]
- *Maintaining bowel health:* By promoting regularity, insoluble fiber helps maintain a healthy bowel environment and may reduce constipation and hemorrhoids.[6]

Gastrointestinal Function: Constipation is a common complaint during pregnancy, mainly due to hormonal changes that slow down digestion.[1]

- **Promotes regular bowel movements**: Fiber adds bulk to stool, making it easier to pass through the digestive system and promoting regular bowel movements.[2] This provides relief from constipation and reduces problems.
- **Softening the stool:** Soluble fiber absorbs water, forming a gel that softens the stool and makes bowel movements easier.[3] This is especially helpful during pregnancy, when constipation can be especially troublesome.
- **Increases gut motility:** Both soluble and insoluble fiber stimulates gut motility, the muscular contractions that move food through the digestive tract. It helps in moving food efficiently and prevents constipation.[4]

Blood Sugar Control

Maintaining healthy blood sugar levels during pregnancy is important for both mother and developing baby. Unregulated blood sugar can lead to complications like gestational diabetes.[5]

Fiber plays a key role in blood sugar control:

- **Slowing down carbohydrate absorption**: Fiber helps to slow down the absorption of carbohydrates from food into the bloodstream. It prevents blood sugar from rising and helps maintain overall glycemic control.[6]
- **Regulating insulin response:** By slowing carbohydrate absorption, fiber helps regulate the body's insulin response, the hormone responsible for managing blood sugar levels.[7] This reduces the risk of gestational diabetes and encourages a healthy pregnancy.

Weight Management

Healthy weight management during pregnancy is essential for both the mother and the child. While weight gain is expected, excessive weight gain can increase the risk of pregnancy complications.[8]

- **Promotes satiety:** Fiber keeps you feeling full longer, potentially helping to reduce calorie intake and prevent overeating.[9]
- **Managing cravings:** Fiber-rich foods are often more filling and satisfying than processed foods, potentially helping to manage pregnancy cravings and promoting healthy eating choices.[10]

Health Benefits of Dietary Fiber during Pregnancy

Dietary fiber has several notable benefits for pregnant women, including improved maternal and fetal health. Here, we'll explore three important parts where fiber plays a vital role:

Gastrointestinal Function:

During pregnancy, hormonal changes can lead to constipation, which is a frequently complained about condition.[9]

Dietary Fiber can Help

- Fiber promotes regular bowel movements by adding bulk to stool and facilitating stool passage through the digestive tract.[10] This reduces constipation and reduces pain.
- Soluble fiber absorbs water to form a gel, softening the stools and making their removal easier.[11] This is especially useful during pregnancy, when constipation can be quite troublesome.
- Soluble and insoluble fiber promote intestinal motility, which helps move food through the digestive system. It promotes effective digestion and reduces constipation.[12,13]

Blood Sugar Control: Pregnancy requires proper blood sugar levels for both the mother and the fetus. Uncontrolled blood sugar levels can result in problems like gestational diabetes.[13]

- Fiber slows the absorption of carbohydrates from food into the circulation. This reduces blood sugar spikes and improves overall glycemic control.[14]
- Fiber reduces glucose absorption and regulates insulin response, which controls blood sugar levels.[12,13] This reduces the risk of gestational diabetes and leads to a healthy pregnancy.

Weight Management: Controlling weight during pregnancy benefits both the mother and the baby. Weight gain during pregnancy is normal, but excessive weight gain can increase the chances of problems.[8-13] Here's how fiber can help:

- Fiber promotes satiation, potentially reducing calorie intake and preventing overeating.[9]
- Fiber-rich foods are more filling and satiating than processed foods, potentially reducing cravings in pregnancy and promoting good eating habits.[10-12]

Potential Impact on Pregnancy Outcomes

Increasing evidence suggests that increasing dietary fiber intake during pregnancy may improve a variety of pregnancy outcomes. Here, we'll look at three important areas:

Excessive gestational weight gain (GWG) can cause complications during pregnancy for both mother and child.[14] According to several studies, there may be an association between higher fiber consumption and a reduction in the incidence of excessive GWG.

This shows that fiber may help promote appropriate weight management when pregnant.

Gestational Diabetes: High blood sugar levels during pregnancy might lead to significant complications. As previously stated, fiber helps manage blood sugar levels. Research indicated that pregnant women who were overweight or obese before pregnancy and took a fiber supplement had a reduced chance of developing gestational diabetes compared to a control group.[16] This shows that fiber might be an effective strategy for regulating blood sugar and perhaps decreasing the risk of gestational diabetes.

Preterm Delivery: Birth before 37 weeks of pregnancy can entail serious health risks for the newborn. Some studies involve a relationship between increased fiber consumption during pregnancy and a lower risk of preterm birth.[4] However, further study is needed to validate this link and better understand the underlying processes.

Effects on Neonatal Health

The advantages of maternal dietary fiber consumption extend beyond the mother and may have an influence on the health of the growing baby. The gut microbiome, the diverse population of bacteria that live in the intestines, is a hot topic of research. The gut microbiota influences digestion, immunological function, and general health. Emerging research shows that a mother's nutrition during pregnancy might influence the first seeding of the baby's gut microbiota.[17] Higher maternal fiber consumption has been linked to a more diverse and favorable gut microbiota makeup in infants.[14–18] This diversified microbiome may help to strengthen the immune system, thereby reducing the risk of allergies and other chronic disorders later in life.[16]

Dietary Fiber Recommendations and Sources

The recommended daily dietary fiber intake during pregnancy varies somewhat depending on the individual's demands and trimester. However, general advice suggests consuming 28 grams of dietary fiber each day.[16]

Sources of dietary fiber to include in a pregnant woman's diet

- Vegetables included artichokes, broccoli, Brussels sprouts, sweet potatoes, peas, and lentils.
- Tremendous sources of dietary fiber.[19]

- Fruits include raspberries, blueberries, strawberries, pears (with skin), and apples (with skin).
- Whole grains include whole wheat bread, brown rice, quinoa, oats, and barley.
- Legumes include kidney beans, black beans, chickpeas, and lentils.
- Nuts and seeds include almonds, walnuts, flaxseeds, and chia seeds.

Table 1: Dietary Fiber Intake During Pregnancy and Its Effects on Maternal and Neonatal Health

Health Area	Positive Effects of Dietary Fiber	References
Gastrointestinal Function	Promotes regularity and reduces constipation, softening stools and helping them pass easily. Enhances intestinal motility for efficient digestion.	3, 21
Blood Sugar Control	Slows carbohydrate absorption, thereby reducing blood sugar rises. Insulin regulates response and controls blood sugar levels. The risk of gestational diabetes may be reduced.	3, 4
Weight Management	Promotes satiety and reduces calorie intake. Enhances feelings of fullness, potentially reducing cravings.	4, 8
Potential Pregnancy Outcomes	Reduces the risk of gestational diabetes. There is a possible link to a lower risk of premature birth	16, 17
Neonatal Health	Affects the development of the baby's gut microbiome. A diverse gut microbiome strengthens the immune system and potentially lowers the risk of allergies and chronic diseases.	21

CONCLUSION

Eating enough fiber during pregnancy can provide many benefits for both mothers and babies, including promoting digestive health, controlling blood sugar levels, and potentially aiding healthy weight management. However, more research is needed to fully understand its effect on specific pregnancy outcomes, such as preterm delivery. Current evidence supports the inclusion of a variety of fiber-rich foods in a balanced and nourishing diet for pregnant women. Future research may include long-term studies, mechanistic studies, personalized dietary recommendations, and fiber supplements. Despite ongoing research, the understanding of the relationship between dietary fiber consumption during pregnancy and specific pregnancy outcomes is still developing. However, evidence suggests that fiber contributes positively to overall maternal and fetus health. As research advances, dietary guidelines for pregnant women may be refined to emphasize the importance of adequate fiber intake. This will provide a comprehensive view of fiber and future directions regarding dietary fiber consumption during pregnancy.

REFERENCES

1. Aziz, T., Hussain, N., Hameed, Z., & Lin, L. (2024). Elucidating the role of diet in maintaining gut health to reduce the risk of obesity, cardiovascular and other age-related inflammatory diseases: recent challenges and future recommendations. *Gut Microbes*, *16*(1), 2297864.
2. Baker, P. M., & Kruger, M. C. (2014). Dietary fibre intake and sources among pregnant women from a low-income, peri-urban South African community. Maternal and child health nutrition, 10(2), 230–240. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5946289/
3. Slavin, J. L. (2013). Fibre and Health: An Overview of Nutrition Reviews, 71 (5 Pt 2), S3–S14. [invalid URL removed].
4. Li, W., Zhang, Y., Li, D., Liu, S., Li, B., & Nie, S. (2016). Effects of dietary fibre intake on satiety

and food intake: a systematic review and meta-analysis. Obesity Reviews, 17(5), 372–383. https://doi.org/10.1111/obr.12382.

5. Anderson, J. W., Davidson, M. H., Jr., Molina, M. J., Charlton, J. A., Longmire, R. L., & Carlson, S. H. (2009). Cholesterol-lowering effects of near-daily consumption of oat bran cereal by hypercholesterolemic men. Archives of Internal Medicine, 169(8), 703–711.
6. Chen, A., Peng, G., & Yang, J. (2016). Potential Mechanisms of Soluble Dietary Fibre on Cholesterol Metabolism. Nutrients, 8(11), 344.
7. McRorie, J. W., & McKeown, N. M. (2017). Understanding the effects of dietary fibre on constipation. Nutrition Reviews, 75(11), 800-807.
8. McRorie, J. W., & McKeown, N. M. (2017). Understanding the effects of dietary fibre on constipation. Nutrition Reviews, 75(11), 800-807.
9. Walker, H. K., & Reyes, J. A. (2010). Pregnancy and constipation. Gastroenterology Clinics of North America, 39 (4), 741–753.
10. McRorie, J. W., & McKeown, N. M. (2017). Understanding the effects of dietary fibre on constipation. Nutrition Reviews, 75(11), 800-807.
11. McRorie, J. W., & McKeown, N. M. (2017). Understanding the effects of dietary fibre on constipation. Nutrition Reviews, 75(11), 800-807.
12. Slavin, J. L. (2013). Fibre and Health: An Overview of Nutrition Reviews, 71 (5 Pt 2), S3–S14.
13. Carlin, B. M. (2014). Gestational diabetes mellitus. The New England Journal of Medicine, 371(18), 1701–1710.
14. fibre Li, W., Zhang, Y., Li, D., Liu, S., Li, B., & Nie, S. (2016). Effects of dietary fibre intake on satiety and food intake: a systematic review and meta-analysis. Obesity Reviews, 17(5), 372–383. https://doi.org/10.1111/obr.12382.
15. Carmichael, A. L., & Abrams, B. S. (2013). Excessive gestational weight gain and adverse pregnancy outcomes. Current Obesity Reports, 2(2), 180–186.
16. Paasche-Orlowska, I., & Gabzdyl, M. (2019). A balanced diet is a crucial factor in maintaining health during pregnancy. Nutrients, 11(7), 1661. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9182711/.
17. Zhu, X., Liu, J., Zhang, Y., Li, M., Li, J., & He, J. (2018). Effects of fibre supplements on gestational diabetes mellitus in overweight or obese pregnant women: A randomised, double-blind, placebo-controlled trial. Nutrients, 10(11), 1487.
18. Zhang, C., Mao, C., & Huxley, R. R. (2015). Dietary fibre intake and risk of spontaneous preterm birth: a systematic review and meta-analysis of observational studies. The American Journal of Clinical Nutrition, 102(6), 1455–1464.
19. https://www.eatright.org/health/essential-nutrients/carbohydrates/fiber.
20. Davis, E. C., Monaco, C., Insel, R., & Järvinen, K. M. Gut microbiome in the first 1000 days and risk for childhood food allergy. *Annals of allergy, asthma & immunology: official publication of the American College of Allergy, Asthma, & Immunology*, S1081-1206.
21. Walker, H. K., & Reyes, J. A. (2010). Pregnancy and constipation. Gastroenterology Clinics of North America, 39(4), 741-753.
22. Barrientos, G., Ronchi, F., & Conrad, M. L. (2024). Nutrition during pregnancy: Influence on the gut microbiome and fetal development. *American Journal of Reproductive Immunology*, *91*(1), e13802.

Review Article

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A Review of Macronutrient Intake Analysis in Diets based on Animal and Plant Source Food in India

Swapan Banerjee

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Abstract

Macronutrients like carbohydrates, protein, and fat are essential for body function and energy. Carbohydrates play significant roles indiabetes and obesity. India's calorie intake primarily consists of carbohydrates, with high-fiber diets being more beneficial. Proteins are vital for living cells and muscle tissue, with over half coming from muscle. Adults should limit saturated and trans fatsto avoid obesity, diabetes, cardiovascular disease, and cancer. An optimal dietary regimen includes nutritious meals, low-calorie meals enriched with vegetables, fruits, whole nuts, moderate animal foods, and low-fat dairy. One of the popular diet types, the Mediterranean diet offers significant nutritional benefits due to its abundant fiber content and slow digestion rates. Western diets usually lack dietary fiber so that high-fiber foods can benefit health. Sufficient water consumption is recommended for metabolism, cellular homeostasis, temperature regulation, and circulatory function. So, overall, a balanced diet consists of carbohydrates, protein, and fat combinedas primary food groups called macronutrients and non-nutrients like fiber, antioxidants, and phytochemicals. This narrative review also emphasized vegetarianism and non-vegetarianism; India's two primary diet types contain plant and animal foodthat provideproportionate macronutrients. Adherence tothe dietary guidelines by dietitians for diet plan preparationand its implementation by patients are two critical aspects that must be practiced strictly.

Keywords: Macronutrients; Animal food; Plant food; Diet planning; Protein; Diet types; Balanced diet.

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INTRODUCTION

Macronutrients, or macros, are essential nutrients for optimal body function, including carbohydrates, protein, and fat. They provide energy and structure, and their intake varies based on personal circumstances, with recommended ranges. A combination of these nutrients is required for optimal health. However, the optimal combination is elusive, and historically, human populations have

survived on diets with varying proportions of these macronutrients.[1]

Carbohydrate

Carbohydrates, constituting 40-85% of the energy consumed by humans, are readily digested in the small intestine. Carbohydrates are categorized as either available or unavailable, and their elevated levels contribute to the risk of obesity.[2] The need for more reliable research tools has constrained the study of macronutrients' impact on human nutrition, namely dietary carbohydrates. Nevertheless, conventional techniques for estimating the carbohydrate content in food have relied on analyzing other components such as protein, fat, water, alcohol, and ash. This approach incorporates both fiber and non-carbohydrate constituents, such as organic acids. The total carbohydrate content can be determined by directly analyzing the masses of specific carbs and fiber.[3]

Carbohydrate in the Indian diet

Carbohydrates are necessary for human meals; monosaccharides like glucose and fructose are present in fruits, vegetables, honey, sucrose, lactose, and milk. Cereals, millets, pulses, root vegetables, and animal diets contain complex carbs such as starches and glycogen. Plant foods provide for 70-80% of the total dietary calories in India. High-fiber diets slow down the absorption of carbohydrates, enhance feelings of fullness, lower blood glucose, and lipids, and are more beneficial for health than low-fiber diets.[4] A study analyzed digestible carbohydrates in the human gastrointestinal tract using enzymes mimicking the human system, focusing on sugars like sucrose, which are crucial components of cereals and sugars. The study employed the modified method of analysis of the Association of Official Analytical Chemists'total dietary technique to ascertain the digestible carbohydrate fractions, such as starches and sugars, in different types of food. Fructose, maltose, and lactose were absent in all rice samples, while the total sugars and starch levels exhibited minor variations attributed to varietal differences.[5]

Source of Carbohydrates

India's calorie intake primarily comprises carbohydrates, comprising 65-70% of the total. The primary sources of carbohydrates in India include rice, wheat, maize, millet, amaranth, barley, starchy vegetables, fruits, and added sweets. Pulses and milk are both sources of carbohydrates. Indian cuisine commonly includes grains, pulses, vegetables, and dairy products, which offer vital amino acids and minerals.[6,7]

Lente carbohydrates

Lente carbohydrates, found in Indian cuisine, are slow-absorbed due to their high viscous fiber content, delaying gastric emptying time and reducing post-meal blood glucose response.[8] The Mediterranean diet is characterized by high carbohydrate content, low levels of saturated fats, and frequent inclusion of slow release starch or lente carbohydrate types. The diet has significant implications for health and disease, and certain foods may provide benefits.[9]

Protein

Proteins are vital constituents of living cells, serving as both structural and functional elements. Muscle tissue accounts for over half of these proteins. Proteins are intricate compounds of several amino acids, with indispensable amino acids acquired from food and nonessential amino acids produced within the body. Proteins serve multiple roles and supply energy. Protein needs differ depending on age, physiological condition, and stress levels. Animal and plant meals are abundant in proteins, with animal proteins offering superior essential amino acids in appropriate ratios.[4,10]

Plant proteins

They are considered lesser quality since they contain fewer crucial amino acids. Including grains, millets, and pulses in one's diet ensures a comprehensive array of amino acids, enhancing the overall quality of proteins consumed.[4] Protein is an indispensable macronutrient in the diet, necessary to maintain human structures and muscles. Amino acids constitute this substance; the human body needs only 22 macromolecules. Insufficient protein intake can result in problems such as stunted growth, muscle atrophy, weakened immune system, and cardiovascular and respiratory complications.[4,10]

Animal protein

Animal protein is a comprehensive protein source containing all the necessary amino acids. It is highly absorbable, with a rate of 90%, and has a digestion rate of 85%. Nevertheless, it harbors significant quantities of uremic toxins and proteolytic bacteria, which can lead to the development of renal disease and hinder proper kidney function. Red meat contains iron, Vitamin B12, Vitamin D, DHA, essential omega-3 fatty acids, and zinc. These nutrients are easily absorbable by the human body

and are found in fish, meat, poultry, dairy products, oily fish, eggs, and dairy products.[4,10]

Fat

Dietary visible fats, such as oils and fats like butter, ghee, and vanaspati, are a highly concentrated energy source, delivering 9 Kcal per gram. They originate from imperceptible lipids in plant and animal-based diets and additional fats and oils such as cooking oil. Fats facilitate the transportation of fat-soluble vitamins and essential polyunsaturated fatty acids. The specific type and amount of fats consumed impact cholesterol and triglyceride levels. Infants and children require sufficient quantities of fat for focused energy. However, adults should restrict their consumption of saturated fat and cholesterol to avoid obesity, diabetes, cardiovascular disease, and cancer.[4]Insufficient dietary fat intake and inadequate protein and carbohydrates can lead to negative energy balance, weight loss, and poor growth. Classical n-3 and n-6 PUFA deficiencies occur in individuals with severe malnutrition or chronic fat malabsorption.[11]

Effect of cholesterol

Elevated consumption of dietary cholesterol leads to an increase in blood cholesterol levels, mainly when derived from saturated fats. It is essential to keep cholesterol intake below 200 mg per day. To decrease the intake of saturated fat and cholesterol, it is advisable to restrict the consumption of high-fat animal products and instead choose low-fat milk. Eating eggs three times per week provides a multitude of nutritional advantages. Existing research does not substantiate that consuming cholesterol through diet heightens the risk of heart disease in those in good health. Nevertheless, the consumption of saturated fatty acids and trans-fats can elevate the risk of cardiovascular disease. Eggs are cost-effective, high in protein and vitamins, nutritionally dense, and low in saturated fats. An optimal dietary regimen should consist of meals rich in nutrients, restricted in calories, and a well-balanced combination of essential elements. Additionally, it is vital to incorporate a variety of vibrant vegetables and fruits into the diet. Additional investigation is required about individuals with diabetes.[4,12]

Source of fat

The importance of fat (visible and invisible) from animal foods is sometimes necessary to achieve optimal health. Low-fat dairy foods, whole nuts, moderately high-fat, saturated-fat, and cholesterol-rich animal foods are also needed. In contrast, ghee and butter are limited. Consume foods rich in alpha-linolenic acids like legumes, green leafy vegetables, fenugreek, and mustard seeds. Eat fish more frequently, limit egg consumption to 3 eggs per week, and avoid ready-to-eat fast foods, bakery foods, and processed foods made from hydrogenated fat. Use fats and oils in moderation and consume various foods for optimal health benefits.[4,12]

Fiber

The Mediterranean diet is anticipated to provide substantial nutritional advantages because of its abundant fiber content, especially soluble fiber, and its slow rates of digestion, which aid in reducing increases in blood glucose levels and insulin release. These meals can also assist in the maintenance of low blood lipids and potentially slow down the progression of non-insulin-dependent diabetes in elderly people.Although extensive data for many years shows the positive effects of dietary fiber on health, Western diets remain deficient in this essential component. The responsibility for this issue rests not only with food firms that process food products lacking in fiber but also with the choices made by customers. A nutritious diet generally carries a price tag of 25-30% higher than an unhealthy diet centered around heavily processed foods. Nevertheless, the accessibility, ease, and affordability of processed foods should not compel us to make detrimental decisions for our health. Opting for high-fiber foods instead of ultra-processed ones as customers can benefit our health and well-being, potentially influencing the strategy of food companies. In our capitalist culture, it is essential to express our preferences through our choices and appreciate preparing meals using fresh products rich in dietary fiber.[13,14]

Water

Water is crucial for metabolism, cellular homeostasis, temperature regulation, and circulatory function. There has yet to be a consensus on human water requirements for different demographic groups due to the complexity of the human water regulatory network. A novel approach focuses on the intensity of a neuroendocrine response, like plasma arginine vasopressin, used by the brain to regulate body water volume and concentration. This method defines hydration and distinguishes it from hypohydration. Consuming less than 24 hours of water adequate intake may

increase the risk of dysfunctional metabolism and chronic diseases.[15]

Balanced Diet

A balanced diet provides all necessary nutrients in appropriate amounts and proportions, blending the four primary food groups. The food needed varies with demographic factors, exercise, and physiological aspects. A balanced diet ideally includes 55%-60% carbohydrates, proteins per kilogram bodyweight or approximately 15-20%, and visible cum invisible fatup to 30% that are variable from person to person. Non-nutrients like dietary fiber, antioxidants, and phytochemicals also benefit health. Antioxidants like vitamins C and E, beta-carotene, riboflavin, and selenium protect the body from free radical damage. Spices rich in antioxidants are also beneficial.[4,16] Fig. 1 shows the as-usual need of food groups to prepare a balanced diet. A balanced diet means consuming maximum staple foods such as cereals and minimizing oils/fats.[16]

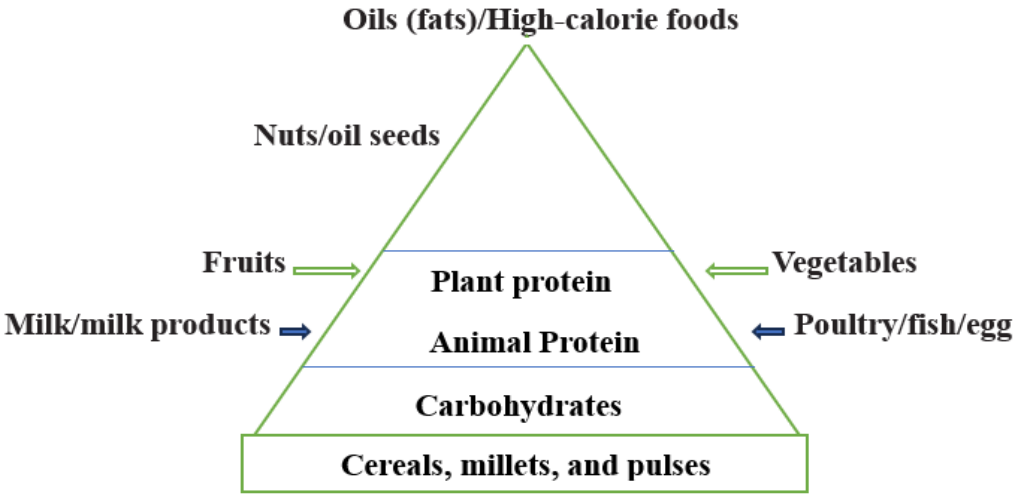

Fig. 1: Food group at a glance for a balanced diet

Table 1 shows the essential food groups and their sources for both sexes by serving sizes and numbers needed for Indians based on sedentary to heavy activities.Cereals, millets, pulses, roots, tubers, and fruits are plant sourced. On the other hand, Meat, fish, eggs, milk and milk products, butter, and ghee are animal-sourced. As per ICMR-NIN guidelines, serving sizes have been multiplied by the serving numbers as needed based on activity type (sedentary to heavy). Table. 2 also shows essential food groups and their sources forIndian women with pregnancy and Indian lactating mothers. As per ICMR-NIN guidelines, serving sizes have been multiplied by the serving numbers as needed based on activity type (sedentary to heavy), and there is an extra need forserving sizes for cereals, pulses, fruits, milk, and milk products, and fat.[4,17]

Table 1: Food groups and their sources needed for Indians as per the serving size and numbers

Food Group	Sources	Male (Sedentary-Heavy)			Female (Sedentary-Heavy)		
Indian perspective	**Common**	***Size (g)**	***No.**	**Total Quantity(g)**	***Size(g)**	***No.**	**Total Quantity(g)**
Cereals/Millets	Plant	30	12.5-20	375-600	30	11-16	330-480
Pulses	Plant	30	2.5-4.0	75-120	30	2-3	60-90
Roots/Tubers	Plant	100	2	200	100	2	200
All Vegetables	Plant	200	3	600	200	3	600
Fruits	Plant	100	1	300	100	1	100
Meat, fish, egg	Animal	100	1	100	100	1	100
Milk and milk products	Animal	100	3	300	100	3	300
Cooking oil	Plant	5	5-6	25-30	5	4-6	20-30
Butter/Ghee	Animal	5	1-2	5-10	5	1	5

**Serving (size/numbers)*

Table 2: Food groups and their sources needed forIndian mothers during pregnancy and lactation as per the serving size and numbers

Food Group	Sources	Pregnancy			Lactation		
Indian perspective	**Common**	***Size(g)**	***No.**	**Total Quantity(g)**	***Size(g)**	***No.**	**Total Quantity(g)**
Cereals/Millets	Plant	30	12.5-20 +1	375-600+30	30	11-16	330-480
Pulses	Plant	30	2.5-4.0+2	75-120+60	30	2-3	60-90
Roots/Tubers	Plant	100	2	200	100	2	200
All Vegetables	Plant	200	3+0.5	600+10	200	3+0.5	600+10
Fruits	Plant	100	1+1	100+100	100	1+1	100+100
Meat, fish, egg	Animal	100	1	100	100	1	100
Milk and milk products	Animal	100	1+2	100+200	100	1+2	100+200
Cooking oil	Plant	5	1+1	5+5	5	1+1	5+5
Butter/Ghee	Animal	5	1+1	5+5	5	1+1	5+5

*Serving (size/numbers)

A study examined the impact of vegan and non-vegan diets on hypothyroidism, kidney diseases, and poor bone health in older adults in Southeast Asia. A total of 95 patients were included in the study, and the results showed no significant difference in TSH, creatinine, bone mass, or calcium levels between vegan and non-vegan diets. However, the food habits group was associated with decreased outcomes. The study pointed out that improper diets can affect these health issues. Southeast Asians are prone to various health issues, including hypothyroidism, chronic kidney disease, and bone health issues, mainly due to poor dietary habits and exercise. Improper vegan or non-vegan diets can affect both male and female older adults, but a healthy diet can reduce disease risks.[18]

CONCLUSIONS

Macronutrients like carbohydrates, protein, and fat are crucial for body function and energy. India's calorie intake is primarily carbohydrates, with high-fiber diets being more beneficial. Proteins are vital for living cells and muscle tissue. Fat is essential to a certain extent, but adults should limit saturated and trans fats to avoid obesity, diabetes, cardiovascular disease, and cancer. An optimal dietaryregimen includes nutritious, low-calorie meals and high-fiber foods. Overall, a balanced diet combines primary food groups and macronutrients.

REFERENCES

1. Venn BJ. Macronutrients and Human Health for the 21st Century. Nutrients. 2020;12(8):2363. Published 2020 Aug 7. doi:10.3390/nu12082363.
2. Gross LS, Li L, Ford ES, Liu S. Increased consumption of refined carbohydrates and the epidemic of type 2 diabetes in the United States: an ecologic assessment. The American Journal of Clinical Nutrition. 2004;79(5):774-779. doi:10.1093/ajcn/79.5.774.
3. Hackett LW. Joint FAO/WHO Expert Committee on Brucellosis; Second Report. The American Journal of Tropical Medicine and Hygiene. 1954;3(1):202-202. doi:10.4269/ajtmh.1954.3.1.tm0030010202a.
4. National Institute of Nutrition-ICMR. (2011). Dietary Guidelines for Indians. A Manual. https://www.nin.res.in/downloads/DietaryGuidelinesforNINwebsite.pdf. Accessed on 5th April 2024.
5. Devindra S, Talari. Analysis of available carbohydrate fractions from Indian foods by using a modified AOAC total dietary fiber method. Indian J Sci Res. 2016; 7:1-9.
6. Joshi S.R., Bhansali A., Bajaj S., Banzal S.S., Dharmalingam M., Gupta S., Mukhopadhyay S., Shah P.R., Sahay R., Sarkar S., et al. Results from a dietary survey in an Indian T2DM population: A STARCH study. BMJ Open. 2014;4: e005138. doi: 10.1136/bmjopen-2014-005138.
7. Srilakshmi B. Nutrition Science. 4th ed. New age international publishers; New Delhi, India: 2012. Proteins; pp. 145–126.
8. Jenkins DJ, Kendall CW, Augustin LS, Vuksan V. High-complex carbohydrate or lente carbohydrate foods?. Am J Med. 2002;113 Suppl 9B:30S-37S. doi:10.1016/s0002-9343(01)00989-5.
9. Wolever TMS, Jenkins AL, Spadafora PJ, Jenkins DJA. Grains, Legumes, Fruits, and Vegetables: Lente Carbohydrate Sources in the

Mediterranean Diet BT -The Mediterranean Diets in Health and Disease. In: Spiller GA, ed. Springer US; 1991:160-181. doi:10.1007/978-1-4684-6497-9_8

10. Prakash D, Gurtoo A, Madhivadhani A. Comparative Study of Plant and Animal Sources of Protein. Published online 2022:1-https://csp.iisc.ac.in/wp/wp content/uploads/2022/07/Comparative-Study-of-Plant-and-Animal-Sources-of-Protein.pdf.
11. Field CJ, Robinson L. Dietary Fats. Adv Nutr. 2019;10(4):722-724. doi:10.1093/advances/nmz052.
12. Soliman GA. Dietary Cholesterol and the Lack of Evidence in Cardiovascular Disease. Nutrients. 2018;10(6):780. Published 2018 Jun 16. doi:10.3390/nu10060780.
13. Barber TM, Kabisch S, Pfeiffer AFH, Weickert MO. The Health Benefits of Dietary Fibre. Nutrients. 2020;12(10):3209. Published 2020 Oct 21. doi:10.3390/nu12103209.
14. Field CJ, Robinson L. Dietary Fats. Adv Nutr. 2019;10(4):722-724. doi:10.1093/advances/nmz052.
15. Armstrong LE, Johnson EC. Water Intake, Water Balance, and the Elusive Daily Water Requirement. Nutrients. 2018;10(12):1928. Published 2018 Dec 5. doi:10.3390/nu10121928
16. Banerjee S. The Essence of Indian Indigenous Knowledge in the perspective of Ayurveda , Nutrition, and Yoga. Res Rev BiotechnolBiosci. 2020;7(2):20-27. http://www.biotechjournal.in/issues.php?yid=20&vid=45.
17. ICMR-NIN Expert Group on Nutrient Requirement forIndians, Recommended Dietary Allowances (RDA), andEstimated Average Requirements (EAR); 2020. Accessedon 5th April 2024.
18. Banerjee S, Ray Pal S. Vegan Vs Non-Vegan Diet Practice and its Effect on TSH, Creatinine, bone mass levels Among Older Adults Living in Southeast Asian Countries. Int J Food, Nutr Diet. 2022;10(2):43-48. doi:10.21088/ijfnd.2322.0775.10222.4

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[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540–7.

[2] Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, *et al*. Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003; 61: 347–55.

Article in supplement or special issue

[3] Fleischer W, Reimer K. Povidone-iodine antisepsis. State of the art. Dermatology 1997; 195 Suppl 2: 3–9.

Corporate (collective) author

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000; 71: 1792–801.

Unpublished article

[5] Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

Personal author(s)

[6] Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

Chapter in book

[7] Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O,

Kidd EAM, editors. Dental caries: The disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. pp 7–27.

No author given

[8] World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979–2001. www.statistics.gov.uk/downloads/theme_health/HSQ 20.pdf (accessed Jan 24, 2005): 7–18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

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