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Development and Analysis of a Dietary Fiber-rich Food Supplement for the Elderly: An Initial Work

Sambaran Mondal[a], Mala Dey[a], Sweety Bardhan[a], Sayantika Saha[a], Neepa Banerjee[b], Shankarashis Mukherjee[a]

[a]*Public Health Analytics Unit, Department of Food and Nutrition, West Bengal State University, Kolkata 700126,India*
[b]*Bhairab Ganguly College, Kolkata 700056,India*

Abstract

Population aging is a predominant phenomenon worldwide. Aging increases the vulnerability of the body and results in the occurrence of health issues. The increasing adaptation of sedentarism in the elderly complicates the situation further. As people are now getting concerned about a healthy diet, the need for the consumption of adequate dietary fiber has been felt for its nutraceutical properties, especially the production of short-chain fatty acids by the gut microbiota. In this backdrop, an attempt is being made to develop a dietary fiber-rich food supplement for the elderly and analyze its properties. Several edible cereals and other edible ingredients were used for the formulation of the supplement. Preparatory and evaluatory methods and techniques were applied. An investigation of the possible mechanisms between the beneficial nutrient molecules and bodily effects has been taken into consideration. The outcome indicates that the supplement is a good source of dietary fiber and can be used for the geriatric diet.

Keywords: Elderly food supplement; fiber-rich supplement; elderly health; dietary fiber; physiochemical properties.

1. Introduction

The world is experiencing a rapid increase in the elderly population. In the year 2020, the world consists of around 100 crores of elderly people (aged ≥60 years), which is estimated to reach about 140 crores by 2030 and will be doubled i.e., will reach 210 crores by the year 2050 [1]. Significant improvements in technology and healthcare facilities lead to a longer lifespan for people worldwide [2]. India, as one of the most populous countries, has also observed a steady rise in its elderly population; the Census 2011 revealed the country consisted of 10.3 crores of elderly persons at that time, which is projected to reach about 23 crores in 2036 and 31.9 crores by 2050 [3,1]. Aging is the inherent irreversible deterioration of body functions over time, which decreases functional ability, causes adjusted quality of life, and leads to death. [4,5]. With aging, physiological functions decrease and the human body becomes prone to the development of diseases and disorders [6,7,8]. The changing lifestyle pattern over decades promoted the adaption of secondary behavior (i.e., activities like sitting or reclining that involve energy expenditure of less than 1.5 metabolic equivalents) and imbalanced dietary intake among the elderly [9], which in turn increases the prevalence of noncommunicable diseases (NCDs), neurodegenerative diseases, all-cause mortality and reduced cognitive function [10-15] and become a threat to the process of healthier aging. The widespread distribution and increment of lifestyle diseases; led people to accommodate different strategies including dietary adaptation of nutraceuticals, especially the addition of dietary fiber to daily diet [16,17,18]. Dietary fiber is composed of Soluble Dietary Fibers (SDFs) (like inulin, pectin, gum, arabic gum, galactomannan, beta-glucans), and insoluble dietary fibers (like

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cellulose, hemicelluloses, lignin), which are able to suppress the occurrence of NCDs and acts as a functional nutrient, as they possess intense physiochemical properties i.e., Water Holding Capacity (WHC), Water Swelling Capacity (WSC), Oil Holding Capacity (OHC), Glucose Absorption Capacity (GAC), Cholesterol Absorption Capacity and Viscosity, have beneficial effect on physiological functions of the human body [19,20,21]. Another recent perspective has been focused over a period i.e., the gut microbiome modulation by the SDFs [22].
SDFs are utilized and metabolized by the gut microbiota to produce beneficial end products, especially the Short Chain Fatty Acids (SCFAs), which plays an important role in reducing the occurrence of gastrointestinal diseases e.g., inflammatory bowel disease, irritable bowel disease, functional constipation, diverticular disease and colorectal cancer [23,24,25]. In this backdrop, an attempt was made to develop a dietary fiber-rich food supplement for the elderly and analyze its physiochemical properties.

2. Experimental

2.1 Materials

Edible cereals like maize and wheat, psyllium husk, and dextrose were used as basic ingredients for the formulation of the food supplement.

2.2 Analytical methods

Several processing techniques such as the application of dry heat, grinding, and mixing were used. No preservative or color was used. Microscopic observations of granules were made. pH was measured using a digital pH meter. Tests for WHC and WSC were performed using standard procedures [19,26,27]. The sensory tests were carried out using the 9-point hedonic scale by 18 consenting nonsmoking, non-alcoholic elderly persons aged 60-65 years, who did not have any oral disease and/or were taste compromised. Nutrient contents were calculated using IFCT, 2017. A preliminary cost calculation was also carried out.

3. Results and Discussions

The structure of the granules of the supplement has been observed under a microscope with 400X magnification.

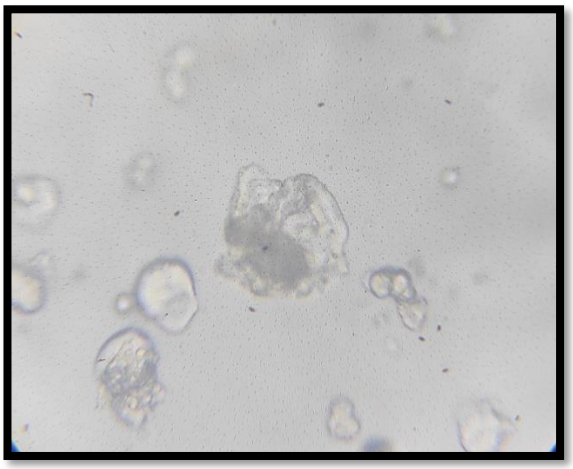

Fig.1: Molecular structure of the molecules under the microscope (400X)

The Physical characteristics in both solid state and after addition of water of the food supplement have been shown in table 1.

Table 1: Physical characteristics of the food supplement

Characteristics	Solid state	After water addition
Texture	Coarse granules	Gel-like structure
Flavor	Sweet	Less sweet
Taste	Sweet	Slightly sweet
Appearance	Yellowish	Yellowish
Smell	Pleasant	No smell

The physiochemical properties of the supplement have been presented in Table 2.

Table 2: Physiochemical properties of the supplement

Properties	Value
pH	6.3- 6.5
WHC *(g/g)*	2.60 ± 0.03
WSC *(ml/g)*	2.40 ± 0.10

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The scores of the sensory tests conducted using the food supplement (solid state) has been presented in Fig. 2.

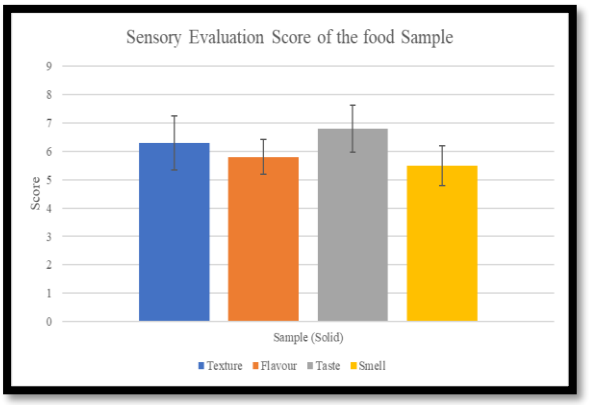

Fig.2: Sensory Evaluation Score (mean) of the food sample (solid)

The calculated nutritive value of the food supplement has been presented in Table 3.

Table 3: Nutritive value (calculated) of the food supplement

Nutrients	Amount *(g)*
Dietary fiber	14.9
Carbohydrate	62.8
Protein	7.7
Fate	2.4
Energy	1290 *(kJ)*

The calculated preliminary cost of the food supplement is INR 19.78, which can increase to INR 22.78 after the inclusion of packaging and labeling costs.

The prevalence of noncommunicable diseases is a global burden and has become the biggest threat to the progress of Healthy Aging worldwide [28]. Dietary fiber possesses significant beneficial characteristics, that help in the prevention of noncommunicable diseases [29]. Dietary fibers like cellulose, hemicellulose, inulin, pectin, etc prevent pathogenic infestation, which is responsible for the stimulation of human immune system, as well as gut barrier function and also helps in production of SCFAs (like acetate, butyrate, propionate) [30].
In vivo studies reported that acetate was responsible for reduction in levels of IL-1β and IL-18 production and increase in NLRP3-inflammasome ubiquitination [31]; the latter is responsible for regulation of NLRP3-inflammasome, a immune system component that increases inflammation and helps in the progression of diseases like atherosclerosis, Alzheimer's, and Inflammatory Bowel Disease [32]. Butyrate increases acetylation, and along with propionate, it regulates glucose homeostasis with the regulation of G-Protein Coupled Receptor-43 (GPR43) AMP-activated protein kinase (AMPK) [33,34]. The food supplement being developed is rich in dietary fiber, and hence expected to provide the health benefits associated with dietary fiber. Microscopic observation of the granules indicated that the molecules of the supplement are capable of holding sufficient water, and physiochemical properties, assessed quantitatively supported it. WHC and WSC help in intestinal peristalsis and motility [35]. Although the texture was coarse in the solid state; when dissolved in lukewarm water, it formed a gel-like structure, and a small change has also been observed in taste. The pH of the supplement on addition of lukewarm water, after bringing down to room temperature is in the range of 6.3 to 6.5, and hence close to neutral. There are several fiber-rich supplements available in Indian market, but they have scope for improvement especially with regard to taste. As with aging, the functions of taste buds decrease, an initial attempt was made and the results of sensory tests performed by elderly individuals confirmed a slight better. The nutritive value calculation shows that the supplement contains about 15g of dietary fiber per 100 g of the supplement, which may able to fulfill half of the recommended daily intake for the elderly as recommended by ICMR. On the basis of the characteristics discussed, it may be concluded that the developed food supplement is rich in dietary fiber, which may be helpful for elderly persons.

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