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Formulation of Nutrient Enriched Cookies from Chia (*Salvia hispanica* L) Seeds - A Pilot Study

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Abstract: Bakery products are most popular segments of food processing industry and can be easily enriched with nutrients and fortify to meet the nutritional requirements. Hence, this study was aimed to investigate the formulation and fortification of nutrient enriched cookies from chia (*Salvia hispanica* L) seeds. In this study, the cookies were prepared and standardized with 30, 20 and 10 % of Chia seeds. The nutrimental and DPPH antioxidant properties of cookies were identified using stranded methodology. The results of the present study indicated that 30% Chia seeds have high nutrient value and content of the nutrient value is 21.76g, 39.91 and 7.2 in carbohydrates, protein and lipid, respectively and free radical scavenging activity was highest inhibition activity in 30% chia seeds (52.06%) at 500 ug/ml concentration. This study indicated that the enriched cookies (30% chia seeds) have more functional components and effective antioxidant capacity. Their supplementation could provide the consumers a novel cereal based product with health promoting benefits.

Keywords: Chia seeds, Cookies, Nutritional content, Antioxidant properties, Radical scavenging

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Introduction

The food industry has a challenge to produce low-cost, nutritive and convenient foods (Drewnowski, 2018). The offer of functional foods has increased, since they have the potential for health promotion, due to the bioactive compounds that are present or added to traditional formulations (Maqsood *et al.,* 2020). In order to meet this demand, it is important to study sources of fibres and antioxidant compounds that are technologically viable, with positive environmental and economic impacts (Gómez-García *et al.,* 2021; Amran *et al.,* 2021). Cookies, as one of the most popular bakery products widely consumed due to their ready-to-eat nature, good nutritional quality (Singhal *et al.,* 2022; Jeon and Lee, 2021), low costs and long shelf-life with dietary fiber (Klunklin and Savage, 2018; Šarić *et al.,* 2019; Gunaseelan and Arun, 2021). Because cookies contain fat in their

formulation, they could oxidize during storage, producing various oxidation products which cause rancidity and deterioration of their sensory properties (Klunklin and Savage, 2018; Vurro *et al.,* 2022). Therefore, shelf-life is one of the major considerations in developing the formulation of cookies.

In recent years most cookies items are high in sugar and have low amounts of antioxidants, fibre, and minerals (Bravo-Núñez and Gómez, 2021). Consumers today tend to choose and eat healthier food, and there is an increasing trend to make cookies and biscuits utilising functional ingredients (Najjar *et al.,* 2022). The use of refined flour results in products lacking the nutritive value of grain in terms of dietary fibres (Crofton and Scannell, 2020). At the same time, achieving the sensory parameters of cookies (taste, texture and colour) that meet consumers expectations, especially while avoiding the use of synthetic additives, can be challenging (Aguilar-Pérez *et al.,* 2021). Antimicrobials, antioxidants, and anti-browning agents are currently used in the food industry as preservative (Bensid *et al.,* 2022). It has been reported that the use of synthetic molecules may be linked to carcinogenesis, and this has led to some restraints on their use. Synthetic preservatives can be replaced by natural extracts from plant origin, which provide bioactive properties and thus increase the nutritive value of the final product (Aguilar-Pérez *et al.,* 2021; Bensid *et al.,* 2022; Najjar *et al.,* 2022). Natural extracts from spices, fruit powder, and aromatic plants for antioxidant purposes have been incorporated in bakery, dairy, and meat products (Aguilar-Pérez *et al.,* 2021; Bensid *et al.,* 2022; Najjar *et al.,* 2022). As the food industry generates high amounts of by-products rich in valuable constituents which can be utilised as functional ingredients, such as antioxidants, incorporating these substances in food would be beneficial environmentally and economically while providing healthier options to consumers (Aguilar-Pérez *et al.,* 2021; Bensid *et al.,* 2022; Najjar *et al.,* 2022). Consumer demand towards functional foods enriched with by-products is increasing due to enhanced awareness of the health and environmental implications of current food choices (Palmieri *et al.,* 2022; Chhikara and Panghal, 2022). Hence, development of cookies fortified with date seeds, the major by-product of the date industry, can generate significant impact environmentally through the reduction of waste financially through the development of a new product and the reduction of waste disposal costs, and societally through the enhanced nutrition made available to consumers. Hence, this present research work aimed to investigate the formulation and fortification of nutrient enriched cookies from chia (*Salvia hispanica* L) seeds.

Materials and Methods

Procurement of raw materials:

The Chia seeds, refined wheat flour, butter, date syrup, chia seed, milk powder, palm jaggery, Sodium hydrogen carbonate (baking powder), and cocoa powder and sooji (ravva) were obtained from local market (Nilgiris supermarket, Uthandi, Chennai) for Cookies preparation.

Preparation and Standardization of Cookies:

Cookies were prepared using the AACC micro method with slight modification. The formulation for the preparation of cookie is represented in the Figure 1. The dough was prepared in a laboratory planetary mixer. Shortening and sugar were creamed together in mixer until soft and spongy texture was formed. Blend of refined wheat flour and TSP was sieved twice with ammonium bicarbonate, salt, baking powder and mixed gently with the creamed mass of shortening and sugar powder mixture. The cookie dough was prepared by adding required amount of water to this mixture. The dough was rolled out and sheeted by rolling pin and cut using a circular cutter of 5 cm diameter. Cookies were baked at 140°C for 15 min, cooled and stored in air tight pouches for the further analysis and the cookies were standardized and formulated as 30%, 20% and 10% chia seed with desired ingredients (Table 1).

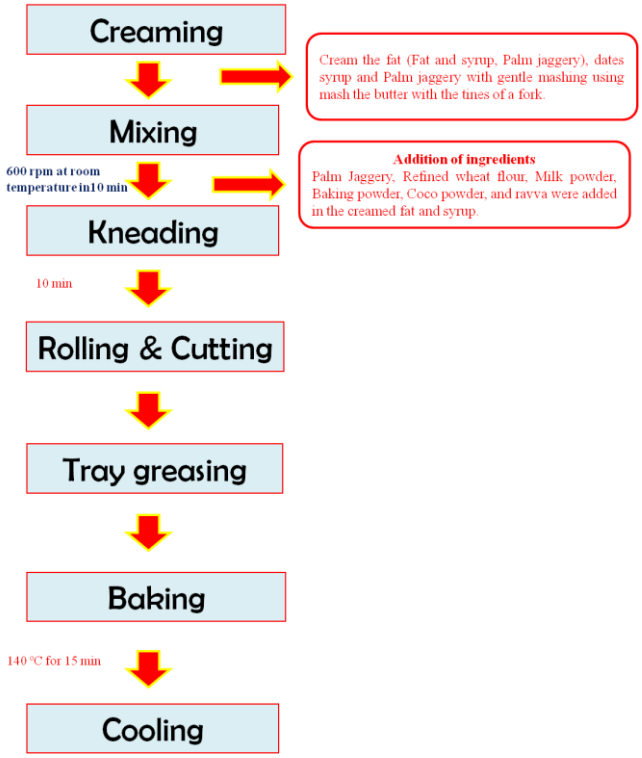

Fig. 1: Schematic representation of preparation of cookies.

Table 1: Standardization of the recipe of chia seeds enriched cookies

% of Chia seeds	Refined Wheat Flour (g)	Chia Seed (g)	Butter (g)	Date Syrup (g)	Palm Jaggery (g)	Rava (g)	Milk Powder (g)	Cocoa Powder (g)	Baking Powder (g)
30	25	30	15	15	10	2	1	1	1
20	25	20	15	15	15	5	2	2	1
10	25	10	15	20	20	4	2	2	2

Nutritional properties of fortified cookies:

The proximate composition of carbohydrate (Dubois *et al*., 1956), protein (Lowry *et al*., 1951), lipid (Folch *et al*., 1957) and ash (AOAC, 1995) content was estimated using stranded methods. The handmade millet cookies are used as control.

DPPH (1,1-diphenyl-2-picrylhydrazyl) radical scavenging assay:

DPPH (1,1-diphenyl-2-picrylhydrazyl) radical scavenging capacity of the formulated cookies were measured by modified method from Nadarajah *et al*. (2017). To 1.25 ml of 60 µM DPPH in ethanol, 250 µl of each cookie extract (micro-centrifuged at 13,000g for 1 min) were added, the decrease in absorbance was monitored at 517 nm after 5 min. The readings were compared with the controls which contained 250 µl of 95% ethanol instead of the sample extract. The % inhibition was calculated using the following formula:

$$\text{Inhibition activity (\%)} = \frac{\text{Abs Sample - Abs Control}}{\text{Abs Sample}} \times 100$$

Where, Abs Sample is absorbance of test samples and Abs Control is the Absorbance of Control reactions (contains all reagents except the test sample). All the experiments were carried out in triplicates.

Results and Discussion

Manufacturing of novel bakery products with elevated functional values such as cookies rich in

Table 2: Nutritional properties of cookies

Parameter	Control (g)	T1 (g)	T2 (g)	T3 (g)
Carbohydrates	15.8	17.21	18.02	21.76
Protein	2.5	2.8	3.01	3.91
Lipid	5.4	5.8	6.32	7.2

Table 3: DPPH free radical scavenging activity of cookies

Concentration (µg/ml)	% of inhibition			
	Control	T1	T2	T3
100	42.6	12.19	14.89	19.87
200	54.21	17.21	22.91	29.05
300	68.32	21.98	29.98	37.21
400	72.08	32.08	37.09	44.34
500	89.04	44.15	47.08	52.06

dietary fibers, bioactive agents, and nutraceuticals is the growing interest of the manufacturers as well as consumers (Birch and Bonwick, 2019; McClements, 2020). Recently, cookies/biscuit technologies have been rapidly developed to improve their nutritional properties (Goubgou *et al.,* 2021). The improvement in cookies/biscuit quality involves primarily novel recipes, process improvement, nutritional enrichment, and health promotion (Ajila, 2008; Goubgou *et al.,* 2021). Cookies available in the market are made using wheat flour (maida or aata) which lack in proteins of high biological value, dietary fibers, few amino acids, minerals etc. (Ghoshal and Kaushik, 2020). Fortification and supplementation of cookies with a variety of proteins and minerals might enhance the nutritional values of the cookies.

Cookies or biscuits represent the largest category of snack item among bakery products (Wani *et al.,* 2015; Batista *et al.,* 2019). It has become one of the popular snack foods for both young and elderly people due to their affordable price, convenience, shelf-stable, and nutritive value (Dinkar and Mishra, 2020). Cookies often refer to a baked product that is generally prepared using three major ingredients (refined flour, sugar, hydrogenated fats, and some minor ingredients such as additives and emulsifiers). Cookies are widely accepted and consumed by almost all profiles of consumers from many countries and therefore offer a valuable supplementation vehicle for nutritional (Ho and Abdul, 2016). It provides an excellent means of improving the nutritional quality (protein, minerals, vitamins, and bioactive compounds) of foods through incorporation of less expensive non-wheat flour for food product enrichment. In this present study, the fortified fish feed prepared by 30 % of Chia seeds showed high nutrient content when compared to commercially available cookies. The content of the nutrient value was 21.76g, 39.91 and 7.2 in carbohydrates, protein and lipid, respectively (Table 2).

Foods rich in dietary fiber and antioxidants can satisfy some of the demands for health benefits (Sakač *et al.,* 2011; Perez *et al.,* 2018). Intake of dietary fiber and antioxidants has been related to the maintenance of health and/or reduction of the incidence of certain diseases (Lobo *et al.,* 2010; Martins *et al.,* 2019; Alasalvar *et al.,* 2020). In the present study, the cookies prepared from 30% chia seeds composition showed high inhibition activity against free radical scavenger and highest inhibition activity was recorded in 52.06% at 500 ug/ml concentration (Table 3).

Conclusion

Based on the results for the composite cookies in

this study, it can be concluded that the 30% chia seeds has enhanced the nutrient content and antioxidant activity against free radical scavenger hence, it can be recommended as a fortifier cookies in functional foods. These findings improve our knowledge on the value of utilising the Chia seeds. Future work could focus on clinical trials where conclusive observations can be made as to how these fortified cookies might positively impact consumer health.

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