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Omega 3 Fatty Acid Enriched Yoghurt from Chia Seed (*Salvia Hispanica*) Extract

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ABSTRACT: This study aimed to investigate the effects of incorporating chia seed oil into yogurt on its nutritional value, sensory attributes, and shelf life. Three different combinations of chia seed oil and yogurt were evaluated for their texture, flavor, and overall acceptability. Results showed that the omega-3 enriched yogurt had a higher content of omega-3 fatty acids and improved fatty acid balance, lower sugar content, and higher protein content compared to regular yogurt. Combination 1 and 2 were found to have desirable sensory attributes and texture, while Combination 3 was not recommended due to excessive oil content and poor sensory attributes. The omega-3 enriched yogurt had a shelf life of 21 days when stored in the freezer, 12 days in the refrigerator, and 3 hours at ambient temperature. This study suggests that incorporating chia seed oil into yogurt can enhance its nutritional value and provide a healthier option for consumers.

KEYWORDS: seed oil, yogurt, omega-3 fatty acids, sensory attributes, shelf life.

I. INTRODUCTION

In recent years, there is a growing demand for healthy-functional foods fortified with bioactive compounds in the international markets, owing to their different health benefits and increased consumer awareness (Liu et al., 2019). One of the most important essential nutrients in dietary patterns are omega-3 fatty acids (O-3FAs) because their regular intake has potential effects on the health improvement of most of the vital organs of the body (such as heart, brain, lung, eyes, joints, skin, etc.) [1-3]. Hence, consuming these long-chain polyunsaturated fatty acids prevents the prevalence of a large number of diseases or inflammatory and autoimmune disorders (Asbell et al., 2018). Also, some of these functional ingredients such as α -linolenic acid, eicosapentaenoic acid, docosapentaenoic acid, and docosahexaenoic acid positively affect mood and behavior reduce adverse psychological symptoms including stress, anxiety, and depression (Mou, Fang 2019) [4-6].

Omega-3 fatty acids have been shown to significantly reduce the risk for sudden death caused by cardiac arrhythmias and all-cause mortality in patients with known coronary heart disease. Flaxseed, Chia Seed, canola oil, and walnuts also are good dietary sources of omega-3 fatty acids. In addition to being antiarrhythmic, the omega-3 fatty acids are antithrombotic and anti-inflammatory [7-9]. In contrast, omega-6 fatty acids, which are present in most seeds, vegetable oils, and meat, are prothrombotic and proinflammatory. Omega-3 fatty acids also are used to treat hyperlipidemia, hypertension, and rheumatoid arthritis [10-12].

II. METHODOLOGY

Step 1: Preparation of Yoghurt Base

Step 2: Addition of chia seed oil to the yogurt base

Step 3: Homogenizing the mixtures using a high shear homogenizer

Step 4: Incubating the mixtures

Step 5: Chilling and storing the yogurt samples (Storage Conditions)

Step 1: Preparation of Yoghurt Base

Heated 150ml milk to about 85-90°C for 30 minutes to pasteurize it. Cooled the milk to 40-45°C. Added the yogurt culture 1:1 (Lactobacillus bulgaricus and Streptococcus thermophilus) and mixed well [13-15].

Step 2: Addition of chia seed oil to the yogurt base

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Added three different combinations of Omega 3 Fatty acid enriched chia seed oil to 23 the yogurt base and mixed well. The amount of chia seed oil added will depend on the desired level of Omega-3 fatty acid enrichment and the concentration of Omega-3 fatty acids in the chia seed oil being used[16-17].

Step 3: Homogenizing the mixtures using a high shear homogenizer

Poured the mixtures into a high shear homogenizer. Homogenized the mixtures at a pressure of around 500-1000 psi for about 10-20 minutes to break down the chia seed oil droplets and created a smooth and homogeneous mixtures[18].

Step 4: Incubating the mixtures

Poured the homogenized mixtures into containers. Incubated the mixtures at 40-45°C for about 6-8 hours to allowed the yogurt culture to ferment and thicken the mixtures[19].

Step 5: Chilling and storing the yogurt samples (Storage Conditions)

Once the combinations of yogurt has set, chilled in the refrigerator to stop the fermentation process. Stored the combinations of yogurt in an aluminum foil sealed beaker at 1°C to 8°C in the refrigerator until ready to consume. Yogurt has been stored in the refrigerator (5°C) and deep chiller (-18°C) for one week. Unopened yogurt samples lasted good condition for one to two weeks in the refrigerator, while the same can last up to one month in the deep chilled freezing condition[20-22].

III. EXPERIMENTAL RESULTS

The products were standardized and were subjected to proximate analysis (determination of Omega 3 FA, fat content, protein content, Fibre content, Cholesterol, sugar and carbohydrates) and organoleptic evaluation within one hour of preparation which was considered as zero days. All experimental recipes were accepted in terms of appearance, texture, smell, taste and overall acceptability[23-24]

Combinations of Yoghurt Preparation

Combinations 1 and 2, which have a lower and medium proportion of chia seed oil respectively, have proven to be more suitable for forming yogurt with desirable texture and sensory attributes. On the other hand, combination 3, which had a higher proportion of chia seed oil, resulted in a greasy surface and a failed yogurt formation[25]. This could be attributed to the excessive oil content, which interfered with the coagulation process of the milk and culture, resulting in a thinner and less viscous texture. Thus, it is evident that the balance of ingredients is critical in achieving the desired texture and sensory attributes of yogurt. While the addition of chia seed oil can enhance the nutritional value of the yogurt[26-27].

Proximate composition of the samples

The samples were tested to determine the fat content, protein content, Fibre content, Cholesterol, sugar and carbohydrates. The following table shows the values obtained after testing of each samples[28]

Nutritional value of Chia seed Oil

Sl No	Parameters	Values
1	Energy	884 kcal
2	Protein	0
3	Carbohydrates	0
4	Saturated Fat	8g
5	Monounsaturated Fat	7g
6	Polyunsaturated Fat	85g
7	Fat	100g
8	Omega 3 FA	64g
9	Omega 6 FA	21g



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The extracted chia seed oil 10ml was tested and it is found that chia seed oil is rich in polyunsaturated fat, Omega 3 FA and Omega 6 FA and it has zero protein and carbohydrate[29].

Nutritional value of Omega-3 Fatty Acid Enriched Yogurt

SI No	Parameters	Values
1	Energy	71 kcal
2	Protein	4.2 g
3	Fat	3.2 g
4	Omega 3 FA	0.5 g
5	Carbohydrate	3.1 g
6	Fibre	0.4 g
7	Cholesterol	7 mg
8	Sugar	1.5 g

Based on the given parameters, it can be observed that the omega-3 fatty acid enriched yogurt contains 0.5 g of omega-3 fatty acids per serving. This is a positive result as omega-3 fatty acids have been associated with various health benefits[30].

Sensory Evaluation

The sensory evaluation for all the 3 samples prepared from various proportions has been examined

Sensory Evaluation - Combination 1

Organoleptic Properties	Panelist 1	Panelist 2	Panelist 3	Panelist 4
Appearance	8	7	9	7
Texture	7	7	9	7
Smell	8	7	9	7
Taste	7	7	9	7
Overall Acceptability	8	7	9	7

The overall acceptability of Combination 1 is 8.25

Sensory Evaluation - Combination 2

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Organoleptic	Panelist 1	Panelist 2	Panelist 3	Panelist 4
Appearance	7	6	8	6
Texture	6	6	7	7
Smell	7	6	8	6
Taste	6	6	7	6
Overall	7	6	8	6

The overall acceptability of Combination 2 is 6.75

Sensory Evaluation - Combination 3

Organoleptic Properties	Panelist 1	Panelist 2	Panelist 3	Panelist 4
Appearance	4	3	5	3
Texture	3	3	4	3
Smell	4	3	5	3
Taste	3	3	6	4
Overall	4	3	5	3

The overall acceptability of Combination 3 is 3.75

Based on the sensory analysis, the following observations were made:

Flavor: Combination 1 (Low Proportions) received the highest scores for flavor from all panelists, while Combination 3 (Higher Proportions) received the lowest scores due to a strong flavour caused by excessive chia seed oil[31-32].

Texture: Combination 1 (Low Proportions) received the highest scores for texture from all panelists, indicating that the proportions of the ingredients in this combination were most suitable for achieving the desired texture of yogurt. Combination 3 (Higher Proportions) received the lowest scores due to undesirable texture[33-34].

Aroma: Combination 1 (Low Proportions) received the highest scores for aroma from all panelists, while Combination 3 (Higher Proportions) received the lowest scores due to the presence of excessive chia seed oil.

Taste: Combination 1 (Low Proportions) received the highest scores for taste from all panelists, while Combination 3 (Higher Proportions) received the lowest scores due to an unpleasant taste caused by the excessive oil

In summary, based on the sensory analysis, it can be concluded that Combination 1 (Low Proportions) is the most suitable combination for preparing yogurt with desirable sensory attributes, while Combination 3 (Higher Proportions) should be avoided due to its excessive oil content and poor sensory attributes. Combination 1 (Lower Proportions) received moderate scores in all sensory parameters and could be further optimized for improving its sensory attributes and Combination 1 could be considered as an alternative option for those who prefer a lighter and less intense yogurt flavor and aroma. However, to improve its texture and flavor attributes, further optimization in the proportions of the ingredients may be required[35].

Probiotic Test

The maximum colony count of lactic acid bacteria that can be justified in yogurt depends on several factors, including the specific bacterial strains present, the manufacturing process, and the storage conditions of the yogurt. Generally, a colony count of at least 1 billion CFU/g of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* is recommended for yogurt to provide the health benefits associated with probiotics[36]. In the United States, the FDA has established a standard of identity for yogurt, which includes a minimum requirement for the number of live lactic acid bacteria per gram of yogurt. According to the FDA, yogurt must contain "not less than 10 million lactic acid bacteria per gram at the time of manufacture" to be labeled as yogurt.

S.NO	PARAMETERS	METHOD	UNITS	RESULTS
1	Lactobacillus Bulgaricus	AOAC 977.27, 19th	CFU/g	1.42 Billion
2	Streptococcus Thermophilus	AOAC 991.20, 18th	CFU/g	1.16 Billion

Storage condition

Omega 3 Fatty Acid Enriched Yogurt was stored in various storage conditions such as Freezer (-18°C), Refrigerator (5°C) and Ambient temperature(24°C) for 17 days and checked every 6 hours periodically.

Shelf Life observation

By observing various storage conditions, it is discovered that Omega 3 Fatty Acid enriched yogurt has a shelf life of 21 days when stored in freezer. For refrigerator conditions, it has a shelf life of 12 days. For ambient condition, it is advisable to consume within 3 hours

Packaging material used for Yogurt

A wide range of packaging materials is used for yogurt products

The most popular material by far in current use for yogurt is thermoformed HIPS in the form of small cups or larger tubs, with either an aluminum foil/plastic laminate or a paper/plastic laminate heat-seal lid or closure. Rectangular paperboard cartons or cups (with or without an aluminum foil layer), glass containers, PP, and blow-molded high density polyethylene (HDPE) containers are all in common use; poly(ethylene terephthalate) (PET), polyvinyl chloride (PVC), polyvinylidene chloride copolymer (PVdC), and polylactate (PLA) have also been used. For Commercial purpose, the above mentioned packaging material can be utilized for Omega 3 Fatty Acid enriched yogurt to increase the shelf life and quality of the product.

IV. CONCLUSION

The incorporation of chia seed oil to yogurt enhanced its nutritional value by increasing the omega-3 fatty acid content and improved the balance of fatty acids. Combination 1 and 2 were found to be more suitable for forming yogurt with desirable texture and sensory attributes, while Combination 3 should be avoided due to its excessive oil content and poor sensory attributes. The omega-3 enriched yogurt has a lower sugar content and a higher protein content than normal yogurt, making it a healthier option. The shelf life of omega-3 enriched yogurt is 21 days when stored in the freezer, 12 days in the refrigerator, and 3 hours at ambient temperature. Overall, the results of this study suggested that the addition of chia seed oil to yogurt enhances its nutritional value and provides a healthier option for consumers.

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