Short Communication

DEVELOPMENT OF ANTIOXIDANT ENRICHED GREEK YOGHURT USING *SENNA AURICULATA* FLOWER POWDER EXTRACT

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ABSTRACT

Greek yogurt is currently the largest growing sector in the dairy industry. Greek-style yogurt, also known as strained yogurt, concentrated yogurt or thick yogurt, is a semisolid fermented milk product derived from yogurt by draining away part of its whey. This study is aimed to develop an antioxidant-enriched Greek yoghurt by incorporating Senna auriculata flower powder extract as a natural functional ingredient. The product combines the rich nutritional profile of Greek yoghurt with the radioactive properties of Senna auriculata, known for its phytochemicals such as flavonoids, phenolic acids and tannins that exhibit strong antioxidant, anti-inflammatory and antimicrobial activities. Three formulations were prepared with 2%, 4% and 6% Senna auriculata extract, each containing 5% sugar to enhance sweetness, mouthfeel and flavour stability. Standard Greek yoghurt processing steps including pasteurization, homogenization, fermentation and chilling were followed to maintain' quality and extend shelf life. All formulations along with a control sample without extract were evaluated for sensory characteristics and antioxidant activity. The incorporation of 4% Senna auriculata flower extract significantly enhanced the antioxidant activity of yogurt, as evidenced by the increase in DPPH radical scavenging activity from 18.25% in the control to 60.46% in the 4% Senna auriculata flower powder extract enriched sample. Sensory evaluation results revealed that the 4% extract formulation achieved the highest acceptability in terms of taste, texture and overall appeal. The findings suggest that incorporating Senna auriculata extract at an optimal concentration of 4% can enhance both the functional and sensory qualities of Greek yoghurt, offering a promising addition to the functional dairy product market.

Keywords: *Senna auriculata*, Antioxidant activity, Yoghurt.

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INTRODUCTION

Yogurt is defined as a fermented dairy product produced by culturing one or more optional dairy ingredients such as cream, whole milk, partially skimmed milk, or skimmed milk with a characteristic bacterial culture containing Lactobacillus delbrueckii subsp. bulgaricus and Streptococcus thermophilus. Yogurt products vary widely in their chemical composition, production methods, flavoring agents, and post-incubation processing techniques. Notably, significant variations in the composition of Greek-style yogurts have been reported across different countries. The macronutrient content of these products can vary considerably, with carbohydrate, fat, and protein contents ranging from 1–12 g/100 g, 0–20 g/100 g, and 3.3–11 g/100 g, respectively (Lange *et al.*, 2020).

Greek yogurt, also known as Greek-style or strained yogurt in Europe, has gained significant popularity in North America in recent years. It is made by straining regular yogurt to remove the whey, resulting in a thicker texture while retaining its characteristic tangy flavor. The unique texture of Greek yogurt also significantly contributes to its sensory appeal (Gyawali *et al*., 2022).

Greek yogurt is widely recognized as a nutrient-dense food that may contribute to increased lean muscle mass and reduced body fat. Its production begins with the homogenization of standardized milk, followed by pasteurization and cooling to an incubation temperature of approximately 40° C. A starter culture is subsequently inoculated into the milk to initiate fermentation. The yogurt is then subjected to a concentration step, which enhances its protein content to approximately 9–10% and results in a characteristically firm texture. The elevated protein content of Greek yogurt has been associated withreduced subjective hunger and prolonged satiety between meals (Yang and Yoon., 2022).

Nowadays herbal medicines are preferred over modern medicine all over the developing countries due to their safety, efficiency and lesser side effects in the health care system. *Senna auriculatais* an evergreen medicine for the treatment of various diseases. *Senna auriculata* is known by different names like (Tanner's cassia) in English, (Avaraam, Avarampoo) in Tamil, Tangedu in Telugu and Tarwar in Hindi (Singh and Jay Shankar 2013). Senna auriculata flowers were dried, powdered and consumed as a substitute for tea, consumed with goat milk for various medicinal purposes.

Senna auriculata, commonly known as Tanner's cassia and referred to as Avaram in Tamil, is a leguminous shrub belonging to the family Fabaceae. It is a perennial plant that typically attains a height of 30 to 60 cm. Traditionally, S. auriculata has been extensively utilized in the treatment of various chronic ailments. The plant is a rich source of bioactive phytochemicals, including volatile oils, alkaloids, glycosides, tannins, and saponins, which contribute to its medicinal properties. All parts of the plant, from root to tip, are considered therapeutically valuable and have been

reported to exhibit antimicrobial, antidiabetic, hepatoprotective, antiperoxidative, antiviral, and antipyretic activities. Notably, the flower buds have been used in the management of diabetes (Girme *et al*., 2018).

In recent times, there has been a growing demand for food with low-calorie and high therapeutic and functional foods . Health-conscious consumers, especially the younger generation are increasingly seeking innovative food products that offer good taste, low-fat content and enhanced health benefits. In line with this tend, the present study aims to develop yoghurt enriched with antioxidants using *Senna auriculata* flower powder extract. This formulation is expected to provide both nutritional and therapeutic advantages while maintaining desirable sensory and textural qualities.

MATERIALS AND METHODS

The ingredients utilized for the preparation of yoghurt include milk, skim milk powder, culture, sugar and *Senna auriculata* flower were procured from the local market in Redhills, Chennai, Tamil Nadu – 600 052. Split the sentence into two and give the details of the raw material procurement.

Senna auriculata flower powder extract

The flowers of *Senna auriculata* were cleaned to remove dust and shadow dried at 40° C for 4–5 days to eliminate residual moisture. The dried flowers were ground into a fine powder using a mortar and pestle, followed by sieving to obtain uniform particle size (Hariharan *et al*., 2023). The aqueous extract of *Senna auriculata* flower powder was prepared following a modified procedure of Sharmila *et al*. (2016). Briefly, 2 g of the powdered material was mixed with 100 mL of potable water and subjected to ultrasonic extraction using an ultrasound processor at 50 W, maintained at 40° C for 35 minutes. The extract was subsequently filtered through muslin cloth and stored at 4° C until further use.

Preparation of Greek yoghurt

As per the procedure of Huang *et al* (2020) the plain yoghurt was prepared. Desai and Sreeja, (2022) described the procedure for the production of Greek yoghurt from plain yoghurt through traditional method using cheese cloth. As per the procedure fresh cow milk was preheated to 40° C and homogenized to 2500 psi, then pasteurized at 85°C for 30 minutes and immediately cooled to 40° C. The yoghurt starter consists of *Lactobacillus delbrueckii* ssp. bulgaricus and *Streptococcus salivarius* ssp. *thermophilus* were added to the milk at the rate of 2% and incubate the temperature of 42°C for 6 hours until a coagulum of yoghurt was obtained. The coagulated mass was made to hung on a clean white muslin cloth for 6 hours to remove whey by draining. It will filter the concentrated yoghurt in the muslin cloth. The concentrated yoghurt mass is called Greek yoghurt which is packaged in polystyrene cups and kept for storage at 5°C.The detailed flowchart is shown as figure 1 and the different treatment of Greek yoghurt using *Senna auriculata* flower powder extract mentioned in Table 1. The ingredient for preparing *Senna auriculata* flower powder extract incorporated Greek

yoghurt (for 100g) is mentioned in Table 2.

Sensory evaluation

Sensory evaluation of the developed yoghurt was conducted using a 9-point hedonic scale by 15 semi-trained panelists, including faculty and students from the College of Food and Dairy Technology, Koduveli, Chennai – 600 052. The assessment focused on flavor/taste, color/appearance, body/texture, and overall acceptability (Ramkumar *et al*., 2025). Evaluations were carried out at room temperature between 3:00 and 4:00 PM. To minimize carryover effects, plain water was provided between samples to cleanse the palate.

Proximate content

Moisture content (oven dry method) was determined by AOAC (1990). The protein content of samples was determined by Kjeldahl procedure described in AOAC (2018). Fat content in the sample was estimated by Soxhlet extraction method (AOAC, 2000). The crude fibre of sample was estimated using a Fibrotron fibre analyzer as per AOAC (2000). AACC (2000) procedure was followed for ash determination. The crude fibre of sample was estimated using a Fibrotron fibre analyzer as per AOAC (2000).

Antioxidant Activity

To evaluate antioxidant activity, 6 mg of DPPH powder were dissolved in 50 ml of ethanol to prepare a homogenous ethanolic DPPH solution. In a clean test tube, 100 µl of the sample extract was mixed with 1 ml of the DPPH solution and 3 ml of ethanol. The mixture was thoroughly mixed and incubated in the dark at room temperature for 120 minutes, allowing antioxidants in the extract to react with DPPH radicals, following the method of Sharmila *et al*. (2016). After incubation, absorbance was measured at 520 nm using a UV-Visible spectrophotometer, and scavenging activity was calculated accordingly.

$$\text{Scavenging activity (\%)} = \frac{\text{A520 blank - A520 sample}}{\text{A520 blank}} \times 100$$

RESULTS AND DISCUSSION

Sensory evaluation

Antioxidant enriched yoghurt was prepared under different treatments and were evaluated for colour, appearance, body, texture, flavour, taste and overall acceptability by a semi-trained panel of judges using 9-point Hedonic scale and the relevant date is represented in Table 3.

The study on incorporating Tanner's Cassia flower powder extract in yoghurt preparation revealed that the T2 (4% tanner's cassia flower extract) treatment was the most favorable in terms of flavor (8.00±0.34), taste (8.20±0.50), color/appearance (8.00±0.44) and texture (8.20±0.25) followed by control and T1 had flavor (7.20±0.34 and 7.60±0.40), taste (7.80±0.50 and 7.60±0.55), color/ appearance (8.60 ±0.44 and 8.40±0.50), and texture (7.80±0.25 and 7.60±0.30) respectively.

Increasing the flower extract content beyond 4% (T3) resulted in a stronger herbal and bitter taste, it reduces overall acceptability. The scores of T3 for flavour (7.40), taste (7.40), colour (7.40), body and

texture (7.80) of the product respectively. Similarly, Hariharan *et al*. (2023) reported that based on the sensory parameters like colour and appearance, flavour and taste, body and texture and overall acceptability, the inclusion level of 3.0 % of Cassia auriculata flower powder was selected as the optimum inclusion level for developing Greek yoghurt with good organoleptic properties as compared to the control Greek yoghurt.

Proximate analysis

The proximate composition of antioxidant-enriched Greek yoghurt prepared with 4% *Senna auriculata* flower extract is presented in Table 4. The antioxidant-enriched Greek yoghurt (4% *Senna auriculata* extract) showed a slightly higher protein content (6.85 g/100g) compared to the control sample (6.72 g/100g), which can be attributed to the concentration effect from whey removal and the contribution of protein from the plant extract. Fat content (3.12 g/100g) remained similar to the control (3.08 g/100g), indicating that extract incorporation did not significantly affect lipid levels. Carbohydrate content (6.35 g/100g) was marginally lower than the control (6.48 g/100g), possibly due to increased lactose fermentation during storage. Moisture content (82.85%) was slightly higher than the control (82.60%), which helped maintain a soft and creamy texture. Ash content (0.96 g/100g) was higher than the control (0.91 g/100g), reflecting the contribution of minerals from the *Senna auriculata* extract. As observed in the findings of Kim *et al.* (2023) the Greek yogurt fortified with apple pomace syrup as functional food had improved consumer acceptance, suggesting the possibility of developing sustainable apple pomace syrup products. Overall, the results indicate that enrichment with *Senna auriculata* extract did not negatively affect the proximate composition and instead provided a minor improvement in proximate content while maintaining desirable yoghurt quality.

Antioxidant properties

The antioxidant activity of the control and T2 samples were evaluated using DPPH assay on the day of production. The incorporation of 4% *Senna auriculata* flower extract significantly enhanced the antioxidant activity of yogurt, as evidenced by the increase in DPPH radical scavenging activity from 18.25±0.40 % in the control to 60.46±0.25 % in the 4% *Senna auriculata* flower powder extract enriched sample. This enhancement is attributed to the high phenolic and flavonoid content of the *Senna auriculata* extract. As reported by Kim *et al.,* (2023) antioxidant activities by DPPH radical scavenging activity, , ferric reducing antioxidant power, and reducing power were also significantly increased with the apple pomace syrup content and fermentation time of Greek yoghurt.

CONCLUSION

This study successfully developed a functional Greek yogurt by incorporating *Senna auriculata* flower extract, a natural source of antioxidants and bioactive compounds. Three formulations containing 2%, 4%, and 6% extract were compared with acontrol to evaluate their sensory

characteristics and antioxidant potential. The 4% extract formulation achieved the highest consumer acceptability, offering an ideal balance between enhanced functional benefits and desirable taste, texture, and overall appeal. These findings indicate that *Senna auriculata* extract can be effectively used as a natural functional ingredient to elevate both the nutritional and sensory value of Greek yogurt. This innovation aligns with the growing consumer demand for health-focused dairy products and presents new opportunities in the functional food market.

Table 1. Different treatment of Greek yoghurt using *Senna auriculata* flower powder extract

Treatments	Details
Control	Greek yoghurt without *Senna auriculata* flower powder extract
T1	Greek yoghurt with 2% *Senna auriculata* flower powder extract
T2	Greek yoghurt with 4% *Senna auriculata* flower powder extract
T3	Greek yoghurt with 6% *Senna auriculata* flower powder extract

Table 2. Ingredient for Senna auriculata flower powder extract incorporated Greek yoghurt (for 100g)

Treatments	Ingredient		
	Greek yoghurt (g)	*Senna auriculata* flower powder extract (ml)	Sugar (g)
Control	95	-	5
T1	93	2	5
T2	91	4	5
T3	89	6	5

Table 3. Sensory evaluation of antioxidant enriched Greek yoghurt

Attributes	Control	T1 (2%)	T2 (4%)	T3 (6%)	F value
Colour and appearance	8.60 ±0.44d	8.40 ±0. 50c	8.00 ±0.44 b	7.40 ±0.34 a	9.389*
Body and texture	7.80 ±0.25 d	7.60 ±0.30a	8.20 ±0.25b	7.80 ±0.25 a	145.890**
Taste	7.80 ±0.50 d	7.60 ±0.55 c	8.20 ±0.50 b	7.40 ±0.34 a	127.773**
Flavour	7.20 ±0.34 d	7.60 ±0.40 c	8.00 ±0.34 b	7.40 ±0.34 a	103.843*
Overall acceptability	7.85 ± 0.27 d	7.80 ±0.27 c	8.10 ±0.27 b	7.45 ±0.27 c	205.432**

Average of six trials; Non-significant – P>0.05; *Significant –P≤0.05; **Highly significant - P≤0.01

Table.4. Proximate composition of control and antioxidant-enriched Greek yoghurt (4% extract)

Parameter	Control4% Extract (T2)t value
Protein (%)	6.72±0.0256.85±0.00582.150**
Fat (%)	3.08±0.08213.1±0.0125.215*
Carbohydrate (%)	6.48±0.0206.35±0.00996.525**
Moisture (%)	82.60±0.05082.85±0.01527.142**
Ash (%)	0.91±0.0120.96±0.01510.220*

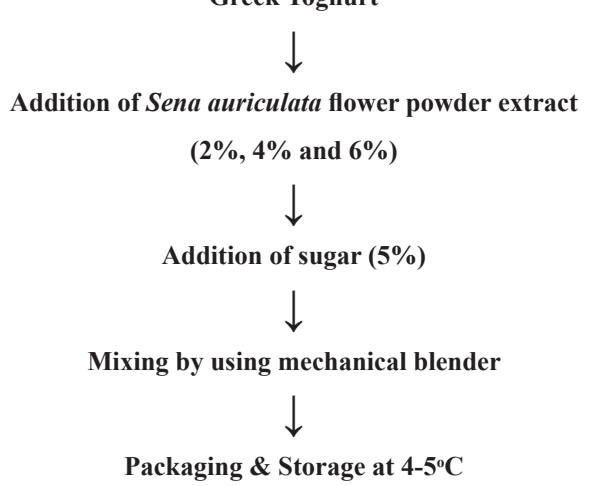

Fig.1. Preparation of Greek yoghurt using yoghurt culture incorporated with *Senna auriculata* flower powder extract

REFERENCES

AOAC, (1990). Official Methods of Analysis. Association of official analytical chemists, Washington, DC 14ª ed.

AOAC, (2000). Official Methods of Analysis. Association of official analytical chemists, Washington, DC 14th ed. 14th

AOAC, (2018). Official Methods of Analysis. Association of official analytical chemists, Washington, DC 16th ed.16th

Desai, R. and Sreeja, V. (2022). Effect of alternate culture yoghurt and straining periods on textural and sensory attributes of Greek yoghurts made using buffalo milk. *Indian Journal of Dairy Science*, **75**: 5.

Girme, A.S., Gaikar, N.V., Saste, G.B. and Kunkulol, R.R. (2018). Chemical studies on antidiabetic botanical drug: *Cassia auriculata*. *Journal of Pharmacognosy and Phytochemistry*, **7**(5): 3417-3424.

Gyawali, R., Feng, X., Chen, Y.P., Lorenzo, J.M. and Ibrahim, S.A. (2022). A review of factors influencing the quality and sensory evaluation techniques applied to Greek yogurt. *Journal of Dairy Research*, **89**(2): 213-219.

Hariharan, V., Karthikeyan, N., Sivakumar, G.M. and Marx Nirmal, R. (2023). Standardization of Greek yoghurt using *Lactobacillus acidophilus* (LA-5) and *Cassia auriculata* flower powder. *The Pharma Innovation Journal*, **12**(12): 2494-2497.

Huang, Y. Y., Yu, J.J., Zhou, Q.Y., Sun, L.N., Liu, D.M. and Liang, M.H. (2020). Preparation of yogurt-flavored bases by mixed lactic acid bacteria with the addition of lipase. *Lwt*, **131**: 109577.

Kim, J., Kim, M. and Choi,I. (2023). Physicochemical characteristics, antioxidant properties and consumer acceptance of Greek yogurt fortified with apple pomace syrup. *Foods*, **12**(9):1856.

Lange, I., Mleko, S., Tomczyńska-Mleko, M., Polischuk, G., Janas, P. and Ozimek, L. (2020). Technology and factors influencing Greek-style yogurt-a review. *Ukrainian Food Journal*, **9**(1).

Ramkumar, R., Manoharan, A.P., Arjunan, S., Thirumalai Rengasamy, P., Pitchaimuthu, S., Janahar, J.J. and Ganesamoorthy, S. (2025). Optimization and characterization of nutrient-fortified milk beverages using conjoint analysis and response surface methodology. *Journal of Food Science and Technology*, **62**(12), 2281-2290.

Sharmila, G., Nikitha, V.S., Ilaiyarasi, S., Dhivya, K., Rajasekar, V., Kumar, N.M. and Muthukumaran, C. (2016). Ultrasound assisted extraction of total phenolics from *Cassia auriculata* leaves and evaluation of its antioxidant activities. *Ind. Crop. Prod*, **84**: 13- 21.

Singh and Jay Shankar., (2013). Plant growth promoting rhizobacteria: potential microbes for sustainable agriculture. *Resonance,* **18**(3): 275-281.

Yang, S. Y. and Yoon, K.S. (2022). Effect of probiotic lactic acid bacteria (LAB) on the quality and safety of Greek yogurt. *Foods*, **11**(23): 3799.