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Standardization of formulation conditions for developing spiced rose petal spread using corn flour as a natural jellying agent

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Abstract
This study focused on developing a spiced rose petal spread using *Rosa damascena* and corn flour as a natural jelling agent, without adding any synthetic additives. The five samples of different formulations (T1–T5) were studied for their sensory attributes, nutritional values, microbial safety, and shelf life. Formulation T1 had the highest TSS (57%), acidity (0.83%), total sugars (50%), reducing sugar (25%), anthocyanin content (249 mg/100g), and vitamin C (60 mg/100g), thus exhibiting an excellent nutritional profile and antioxidant capacity. The product remained microbiologically safe and nutritionally stable for two months. The potential synergistic effect of the rose petals and ginger would add a unique flavour and medicinal properties such as anti-inflammatory and digestive benefits. T1 has a great speculative future as a functional, natural, and value-added food product.

Keywords: *Rosa damascena*, rose petal spread, corn flour, sensory evaluation, vitamin C, anthocyanins

Introduction
The petals of *Rosa damascena* are popularly known for their aroma, taste, and beneficial properties. Their use within food products, especially functional foods, is fast emerging in response to consumers' desire for natural, health-promoting alternatives. Temperate climates are required for the cultivation of roses in many forms, including cut flowers, for essential oils, and cooking (Malakar *et al*., 2023) [8]. Rose petal inclusion has typically been limited to rose water and jams, and now their inclusion within functional foods is emerging in new product categories. Spreads are soft, ready-to-eat foods typically used on bread, crackers, or pastries. Common examples include butter, cheese, jam, and peanut butter, known for their smooth, creamy texture achieved through mixing or jellying agents. This study explores using rose petals as the main ingredient for a unique, flavourful spread, enhanced with spices. Natural corn flour will serve as a jellying agent to ensure consistency, while keeping the product clean and health-friendly (Bandyopadhyay *et al*., 2023; An *et al*., 2023) [3, 1]. This research aims to create a spiced rose petal spread using ginger for enhanced flavour and thereby using corn flour as a natural jellying agent in order to create a spreadable consistency without compromising with the nutritional value of the rose. Corn flour would add some body to the spread but would also be considered as a clean-label, preservative-free ingredient. The spread would also provide therapeutic health benefits due to the presence of bioactive compounds like antioxidants, essential oil, anthocyanins, and vitamin C. A spiced rose petal spread formulation based on corn flour as a natural jellying agent would be an ideal alternative for such consumers (Dinkova *et al*., 2022) [4]. Examples of therapeutic health benefits of consuming such products, which may include improved digestion, anti-inflammatory properties, and improved immunity. Current research aims to standardize the formulation of this spread, but also include sensory attributes, nutritional profile, microbial quality, and shelf-life sustainability in order to ultimately determine the potential for its commercial production

Materials and Methods
The experimental study was carried out in the facilities of the Department of Horticulture, School of Agricultural Sciences, Joy University, which has well-equipped food processing

and food analysis setup. Fresh *Rosa damascena* petals were sourced from Thovalai Flower Market in Kanyakumari, Tamil Nadu. The *Rosa damascena* petals were selected, because it has abundant source of essential oil and as well as bioactive compounds (antioxidants) that can be used for culinary and medicinal purposes. The petals were harvested in the early morning in order to retain the essential oil and also to retain most of the bio-active compounds. Only clean petals that were free from insects/pests were picked and transported to the laboratory under controlled conditions. The petals were washed with cold water to avoid contamination and dust. The petals were then mechanically detached from the stem. The petals were then washed once again thoroughly by hand before preparing the rose extract. For the preparation of the concentrated rose extract, petals of *Rosa damascena* were blended with water in a 6:1 ratio. Next, in order to recover the rose extract, the extract was filtered, which can further remove extractants and provide crystal clear solution, that would be the base for the preparation of the spreads. Five different spreads preparations starting from T1–T5 were made using different percentages of rose petal, ginger juice, corn flour, and sugar. The preparation of the five spreads followed same procedures of preparation. The filtered rose extract was whisked with the same amount of sugar (1:1) with incorporated lemon juice during its preparation. The lemon juice was used for two reasons: to either improve the overall flavoring, thereby reducing the pH thus aiding in formation of the soft gel. The mixture should now be boiled to moisture reduction and for futher flavor enhancement. The addition of corn flour at various levels determined the desired consistency of the product, while the ginger juice was added for its flavor and to achieve functional benefits. The mixture was boiled further until it reached a semi-solid, spreadable consistency. Lastly, the hot spread was put into glass jars, which were sterilized to ensure hygiene and to extend shelf-life. At each formulation, thirty trained panelists evaluated the appearance, aroma, flavor, texture, and overall acceptability on a 10-point hedonic scale. The AOAC methods were utilized to evaluate Total Soluble Solids (TSS), acidity of spread by Savarese *et al*., (2022) [9], total and reducing sugars as per the procedure of Gandhi *et al*., (2017) [5]. The Vitamin C, and anthocyanins was carried out as per the protocol of Li *et al*. (2021) [7]. The test for microbial safety involved estimating Total Plate Count (TPC), yeast and mold, and coliform detection as per AOAC. The samples were evaluated for two months by storing them at room and refrigerated temperature conditions in order to study the storage effects of the spread on color, flavor, texture, nutrient content, and microbial growth changes.

Plate 1: Sequential Steps involved in preparation of Spiced Rose petal Spread

Results and Discussion

Formulation T1 was the most preferred formulation based on the sensory evaluation score. It received the highest scores out of all products evaluated for: color (9.66), aroma (8.44), taste (7.83), texture (7.94) and overall acceptability (8.46). The formulation was praised for its bright, rich, red color, pleasantly sweet and floral spicy aroma, rich taste and ideal semi-solid, spreadable texture. These findings are in agreement with the results of Kumar *et al*. (2020) [6] in guava and papaya mixed fruit jam. Formulation T1 also exhibited superior physiochemical traits, including the highest total soluble solids (TSS, 57%) providing an ideal mouthfeel and lowest acidity (0.83%) aiding preservation and taste. Total sugar was 50% and reducing sugars was 25% enhancing flavour development. These findings were agreed with the results of (Shubham & Uday, 2020) [10] in Cauliflower and, (Ayala *et al*., 2021) [2] in orange fruit. The recorded Vitamin C was 60mg/100g and anthocyanins were 249 mg/100g demonstrating its high health benefits and antioxidant value. Microbiological analysis confirmed that all formulations were found to be safe for consumption. Total plate counts (TPC) were recorded between 2-3 log CFU/g and yeasts and molds were less than (<1 CFU/g) while coliforms were not detected, demonstrating their low levels of pathogen contamination during manufacturing and that they were safe for consumption. Storage stability studies further support the robust formulation of T1. with over two months of ambient storage, the spread maintained its color, texture and flavor profile. Losses in vitamin C, and anthocyanins were minimal, and microbial counts remained in a safe range. Ultimately, there was no major spoilage or sensory loss during the two-month study, demonstrating excellent shelf stability of the product.

Table 1: Sensory evaluation of fresh spiced rose petal spread

Treatments	Colour	Aroma	Taste	Consistency	Overall Acceptability
T1	9.66	8.44	7.83	7.94	8.46
T2	7.44	7.56	7	6.44	7.11
T3	7.89	8	7.44	7.36	7.66
T4	7.89	7.67	7.11	7.13	7.45
T5	8.55	7.3	7	6.06	7.22

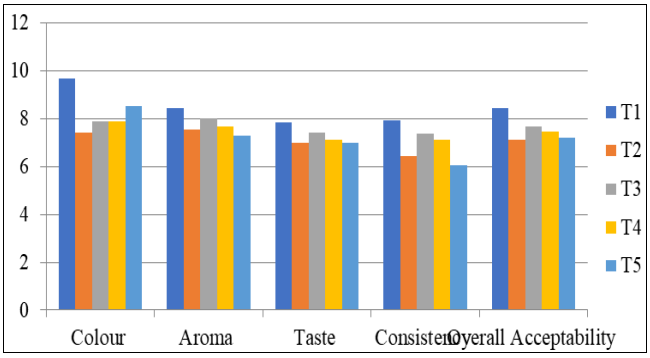

Fig 1: Graphical representation of the sensory evaluation of fresh spiced rose petal spread

Plate 2: Conducting sensory evaluation by various trained panelists for the formulated product

Table 2: TSS Content of fresh spiced rose petal spread

Treatments	TSS
T1	57%
T2	51%
T3	53%
T4	52%
T5	50%

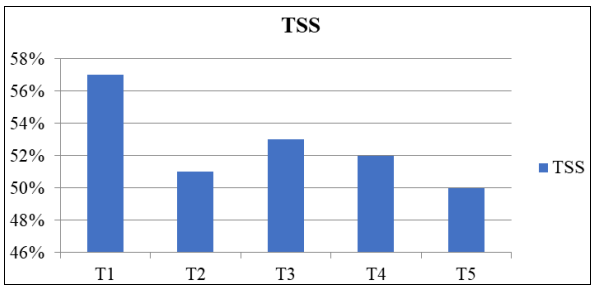

Fig 2: Graphical representation of TSS content in fresh spiced rose petal spreads)

Plate 3: Pictorial representation of various spiced rose petal spread sample projected for performing TSS analysis

Table 3: Acidity Content of fresh spiced rose petal spread

Treatments	Acidity (%)
T1	0.83
T2	0.72
T3	0.26
T4	0.23
T5	0.43

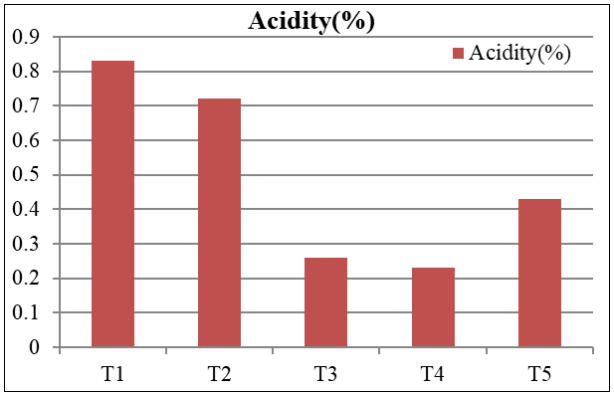

Fig 3: Graphical representation of acidity content in fresh spiced rose petal spreads

Plate 4: Pictorial representation of various spiced rose petal spread sample projected for per performing acidity analysis

Table 4: Total Sugar Content of fresh spiced rose petal spread

Treatments	Total sugar content
T1	50%
T2	46.71%
T3	48.15%
T4	47.94%
T5	45%

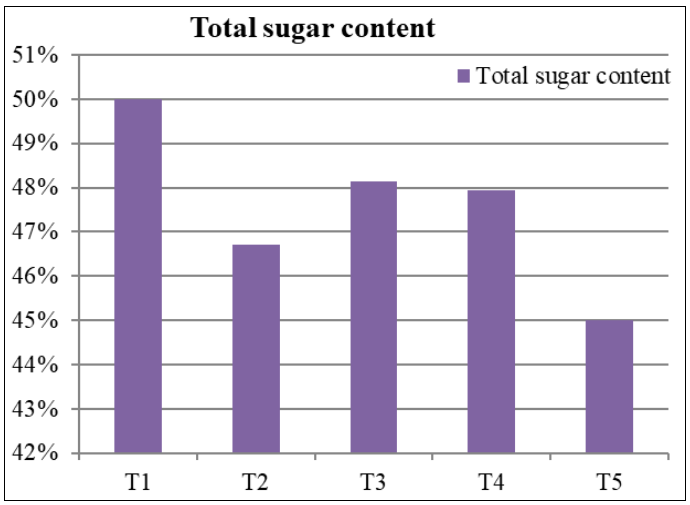

Fig 4: Graphical representation of total sugar content in fresh spiced rose petal spreads

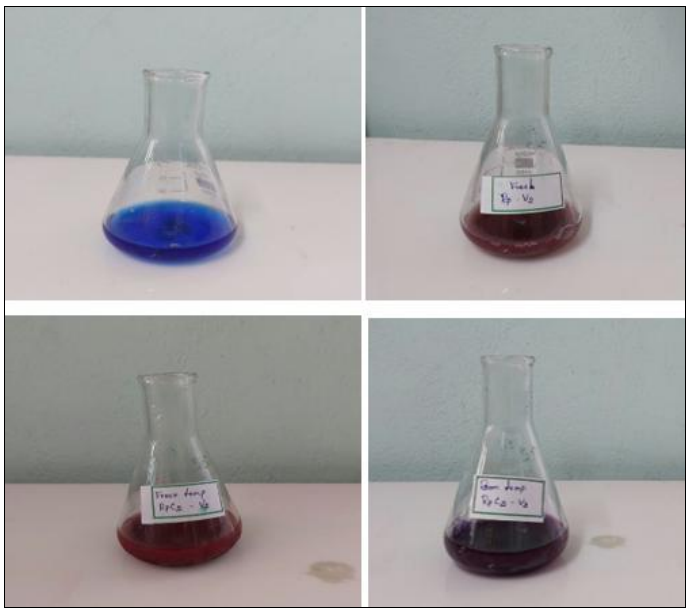

Plate 5: Pictorial representation of various spiced rose petal spread sample projected for performing Total sugar analysis

Table 5: Reducing Sugar Content of fresh spiced rose petal spread

Treatments	Reducing sugar Content
T1	25%
T2	22.78%
T3	21.43%
T4	21.64%
T5	20%

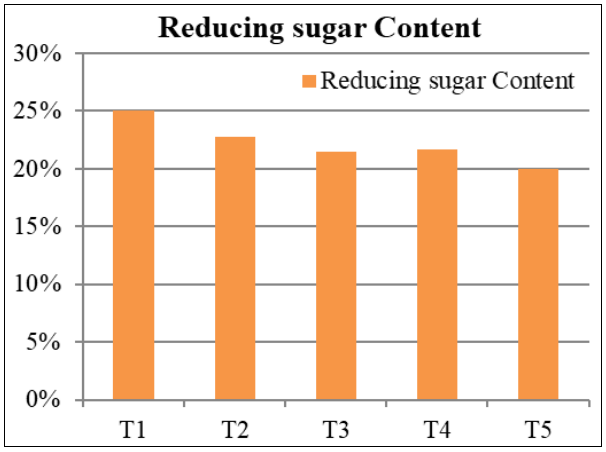

Fig 5: Graphical representation of reducing sugar content in fresh spiced rose petal spreads

Table 6: Vitamin C Content of fresh spiced rose petal spread

Treatments	Vitamin C (mg per 100 g)
T1	60
T2	53.22
T3	54.39
T4	56.38
T5	50.01

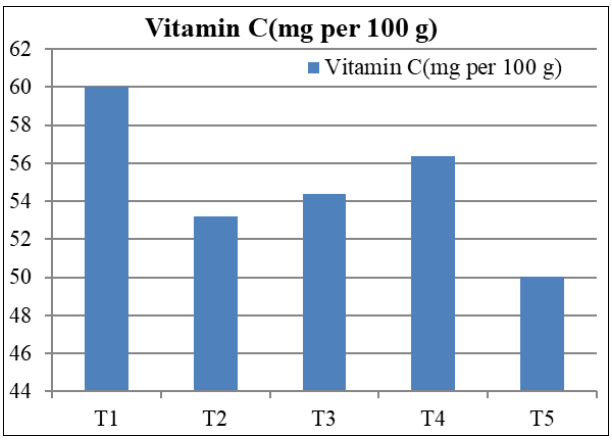

Fig 6: Graphical representation of vitamin C content in fresh spiced rose petal spreads

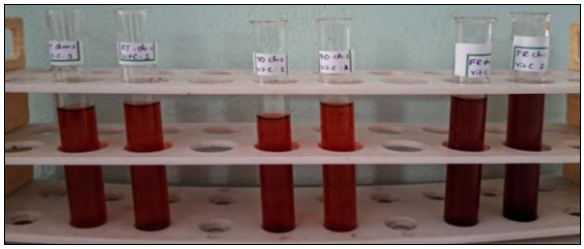

Plate 6: Pictorial representation of various spiced rose petal spread sample projected for performing Vitamin C analysis

Table 7: Anthocyanin Content of fresh spiced rose petal spread

Treatments	Anthocyanin
T1	249 mg
T2	210 mg
T3	230 mg
T4	190 mg
T5	170 mg

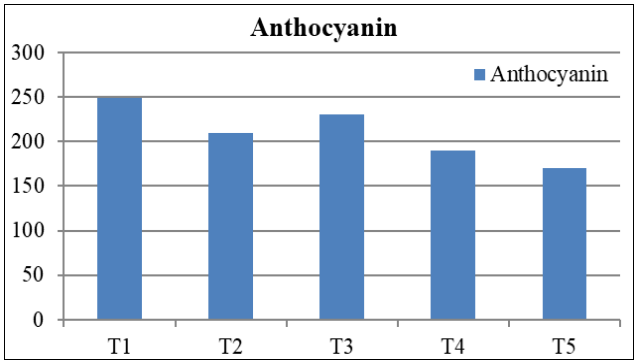

Fig 7: Graphical representation of anthocyanin content in fresh Spiced rose petal spreads

Conclusion

The development of a spiced rose petal spread using *Rosa damascena* and corn flour to act as a natural jellying agent. which yielded a delicious, nutritious, and stable product. The formulation T1 was particularly well accepted by consumers with high sensory scores and favorable nutritional and microbial profiles. The presence of anthocyanins, vitamin C and ginger improves the product appeal and aids in achieving its therapeutic value in relation to consumer interest in clean-label and health-promoting foods. Overall, with its sensory appeal, nutritional properties, and established shelf stability, T1 has good prospects for commercialization as a new, value-added, and functional food product.

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