Asian J Biol Life Sci., 2026; 15(2):518-529.
https://ajbls.com

Research Article

Preparation, Sensory and Nutritional Evaluation of *Alternanthera sessilis* Chips

Patteti Jessy Jyothsna, Karri Jagannadham*, Narender Vaishnavi, Karka Gayathri, Dhagnapoor Prasanna Kumari

Department of Clinical Nutrition and Dietetics, School of Allied and Healthcare Sciences, Malla Reddy University, Hyderabad, Telangana, INDIA.

ABSTRACT

Background: *Alternanthera sessilis* is a nutrient-rich leafy plant containing vitamins, minerals, dietary fiber, flavonoids, and carotenoids with antioxidant and anti-inflammatory properties. **Materials and Methods:** The present study aimed to develop value-added chips incorporated with *Alternanthera sessilis* leaf powder and evaluate their sensory, nutritional, and storage qualities. Sensory evaluation revealed that formulation T2 was the most preferred, with appearance (7.80±0.61), colour (7.90±0.85), flavour (8.25±0.71), taste (8.25±0.55), texture (8.20±0.76), and overall acceptability (8.20±0.89) scores, compared to the control sample (T0), which recorded 6.85±0.74, 7.50±0.76, 7.15±0.81, 7.45±0.68, 7.25±0.78, and 6.65±0.87, respectively. **Results:** Nutritional analysis showed that increasing the level of leaf powder enhanced protein content from 8.69% to 11.07%, total fibre from 4.18% to 13.77%, iron from 2.54% to 3.67%, and ash content from 3.23% to 5.08%. In contrast, fat decreased from 3.44% to 2.45%, moisture from 5.62% to 2.17%, carbohydrate from 75.12% to 65.71%, and energy value from 366.24 to 332.53 kcal/100 g. Storage studies conducted over 30 days indicated a gradual decline in sensory attributes due to moisture absorption and loss of crispness; however, the chips remained organoleptically acceptable throughout the storage period. **Conclusion:** The study concludes that incorporation of *Alternanthera sessilis* leaf powder significantly improves the nutritional profile and sensory quality of chips, making them a healthy functional snack with good storage stability and consumer acceptance.

Keywords: *Alternanthera sessilis* air-fried chips, Functional Snack, Leaf Powder, Sensory Evaluation, Nutritional Analysis.

Correspondence:
Dr. Karri Jagannadham
Department of Clinical Nutrition and Dietetics, School of Allied and Healthcare Sciences, Malla Reddy University, Hyderabad-500043, Telangana, INDIA.
Email: karrijagannadham@gmail.com

Received: 06-04-2026;
Revised: 15-06-2026;
Accepted: 21-07-2026.

INTRODUCTION

The generic name Alternanthera is derived from the ancient Greek words alternans meaning “alternating” and anthera meaning “anther,” referring to the alternation of pseudo staminodes and stamens in the flower. The species name sessilis refers to flowers that lack a pedicel (stalk). The exact origin of Alternanthera sessilis is uncertain due to its pantropical distribution; however, it is widely found throughout the Old-World tropics, including tropical Africa, Southern and Eastern Asia, and Australia (Mrinmay & Ashok, 2014). Sessile joyweed (Alternanthera sessilis) is a leafy vegetable belonging to the family Amaranthaceae. It exists in two main varieties: the green variety (ASG) and the red variety (ASR) (Subhashini et al., 2010). Alternanthera sessilis is valued for its rich nutritional composition, including minerals, vitamins, dietary fiber, flavonoids, and carotenoids. According to traditional Siddha literature, the herb is believed to contain traces of gold and is therefore classified under the kaya kalpa category, which comprises rejuvenating remedies. Alternanthera sessilis contains several bioactive compounds with antioxidant and anti-inflammatory properties. Antioxidants present in the plant inhibit oxidative chain reactions initiated by free radicals, thereby protecting biomolecules from damage. Bioactive constituents such as vanillic acid, ethyl gallate, apigenin, chlorogenic acid, catechin, and epigallocatechin contribute to its anti-inflammatory activity (Sunmathi et al., 2016).

Fresh leaves of Alternanthera sessilis contain approximately 80 g/100 g moisture and provide about 251 kJ/100 g of energy. The proximate composition includes 4.7 g/100 g protein, 0.8 g/100 g fat, and 11.8 g/100 g carbohydrates. The leaves also contain starch (3.2 g/100 g), amino acids (0.225 mg/100 g), Vitamin B1 (2.76 mg/100 g), Vitamin B2 (12.6 mg/100 g), fiber (2.1 g/100 g), Calcium (148 mg/100 g), and phosphorus (45 mg/100 g). In addition, the plant is rich in flavonoids (Rajapakse & Beneragama, 2016). Commonly called, it is the most widely produced and most popular of nine leafy vegetables cultivated and sold on a commercial scale in Sri Lanka (Lin et al., 1994). It is easy and inexpensive to cultivate, damage during transport is minimal,

DOI: 10.5530/ajbls.20260185

and once cultivated it can be harvested on a monthly basis for about two years. The plants are shredded finely and stir-fried with grated coconut and spices to be eaten with rice. In many places of the world, other than Sri Lanka, the leaves and stems of A. sessilis are eaten as a cooked vegetable. In tropical Africa, its use as a vegetable has been reported from Guinea, Benin (in sauces and soup), Nigeria (in soup), Congo, Tanzania, and Zambia (as a relish), as well as from Madagascar and Réunion (as a pot herb) (Alwis et al., 2006).

Wheat is one of the most important staple foods worldwide and serves as a significant source of proteins, minerals, B-complex vitamins, and dietary fibre compared to many other cereal crops. It is widely used in the preparation of a variety of food products. The wheat grain is composed of three main anatomical parts: bran (13-17%), germ (2-3%), and endosperm (80-85%), each contributing essential nutrients. On average, the wheat kernel contains approximately 70% carbohydrates, 12% water, 12% protein, 2% fat, 1.8% minerals, and 2.2% crude fibre. It is also rich in essential micronutrients such as phosphorus, magnesium, manganese, zinc, selenium, iron, potassium, and copper (Liu et al., 2012). Thousands of wheat cultivars with diverse grain and flour characteristics are cultivated worldwide. These varieties are commonly classified according to planting season (winter or spring), grain colour (white, red, or pigmented), and endosperm texture (vitreous or mealy; soft or hard) (Shewry, 2023).

Hard wheat grains generally produce strong flour with higher protein content, making them suitable for bread production. In contrast, soft wheat varieties yield flour with lower protein content and reduced starch damage, which is desirable for manufacturing high-quality cookies, biscuits, and pastries (Quayson et al., 2016; Shang et al., 2020; Sharma et al., 2022). Globally, about 65% of total wheat production is consumed directly by humans. From a nutritional perspective, wheat germ is a rich source of essential vitamins, and deficiencies in these nutrients may contribute to various cardiovascular diseases (Anju et al., 2021). Cereals play a vital role in a balanced diet and constitute one of the most important staple food groups worldwide. Among them, wheat is the most widely consumed cereal and is used in the preparation of numerous food products such as bread, noodles, and biscuits. In recent years, black wheat has emerged as a promising alternative due to its superior nutritional profile compared to conventional wheat varieties (Joshi et al., 2022).

MATERIALS AND METHODS

Materials

The raw materials like *Alternanthera sessilis* leaves, pigeon peas, black gram and wheat flour and other ingredients for the preparation of chips was purchased from the local market, Hyderabad, Telangana, India. These ingredients were grounded to prepare *Alternanthera sessilis* chips.

Study Area Description

The study was conducted in a controlled laboratory environment of CND, Malla Reddy University, equipped with modern food processing machinery and analytical tools. The sample preparation, sensory evaluation and nutritional analysis were carried out in Food Science laboratory of CND.

Preparation of *Alternanthera sessilis* leaf powder

Fresh leaves of *Alternanthera sessilis* are separated and thoroughly washed to remove dirt. The leaves are then shade dried for about 10 to 25-30 days until completely dry to avoid direct sunlight which may degrade some compounds. After drying, the leaves are ground into a coarse or fine powder using a mechanical grinder and sieved. The powder is then stored in an airtight container in a dry place to protect it from moisture.

Preparation of pigeon pea and black gram flour

Pigeon pea and black gram were roasted slightly and kept aside to cool at room temperature. The cooled pigeon pea and black gram seeds were ground to form a fine flour using a grinder.

Preparation of Chips

Chips were be prepared by the method of Bimal chitrakar *et al*. (2023) with a slight modification. Asparagus chips were prepared with 30%, 40%, 50% (w/w) of leaf powder as per the formulation presented. For preliminary evaluation of the optimum level of asparagus-leaf powder in terms of its sensory (especially, the texture), a team of sensory evaluators, processed in the kitchen blender for few seconds. The mix was ready for making chips with the help of a high-pressure molding. For each chip, both the amount of the mix taken (a spoonful) and the amount of the pressure applied (the number of hits by a hammer) were maintained the same. Such made chips had dimension of 17 mm diameter and 5 mm thickness with 1.25 g in weight. Six types of chip samples containing different particle sizes were prepared as shown in Table S1 (Supplementary Material), which were kept in an ultra-low temperature fridge at 65°C for 12 hr. chips were then dried under the vacuum degree of 80±5 Pa. When the temperature of vapor condenser was less than 40°C, the chips (about 300 g) were loaded into the drying chamber. Drying plate temperature was maintained at 50°C and drying was continued until the moisture content of the chips reached less than 4%. The samples were dried for 75 min. Samples were collected at 15 min intervals to determine moisture content, water activity, and LF-NMR spectroscopy. All collected samples were packed in aluminum foil zip-lock bags and stored in a desiccator for further analysis (Bimal et al., 2023).

Effect of Storage period of Chips

Alternanthera sessilis chips incorporated with pigeon pea and black gram flour are stored in an air tight container. The Effect of storage duration on chips sensory attributes is assessed during the 0th day, 15th day and 30th day.

Statistical analysis

The samples were examined by three analyses. Microsoft Excel 2019 is used to determine the mean score and standard deviation of three replicates for each test. The Statistical Package for Social Sciences (SPSS) has been used to perform a One-Way Analysis of variance (ANOVA) on all of the gathered data. Means were compared using LSD with a $p<0.05$ cutoff value.

RESULTS AND DISCUSSION

Sensory analysis of control and experimental chips

Sensory analysis of control and experimental chips was described in Table 2.

The appearance scores of the control and experimental chips were 6.85±0.74, 7.40±0.82, 7.80±0.61, and 7.75±0.63, respectively. As shown in Table 1, the highest appearance score was observed in the T2 sample (7.80±0.61), whereas the control sample T0 (6.85±0.74) recorded the lowest score. These findings are in agreement with the study by Coorey et al. (2012), who reported that the appearance score of Treatment 1 chips (6.52%) was higher than that of the control sample (6.21%). The lower appearance observed in the control sample of the present study may be attributed to the absence of the experimental ingredient, which could have enhanced surface uniformity, colour distribution, and overall visual appeal in the formulated samples (Figure 1) (Coorey *et al*., 2012).

The colour scores of the control and experimental chips were 7.5±0.76, 7.7±0.86, 7.9±0.85 and 7.65±0.67 respectively. The highest colour score was observed in T2 sample (7.9±0.85), whereas the control sample T0 (7.5±0.76) recorded a lower score indicating better visual appeal in T2 compared to the control. These findings are in agreement with the study by Ratchanee *et al*. (2015), who reported that the colour score of the 8% BBQ flavour treatment (6.36%) was higher compared to the control sample (5.96%). The lower colour score observed in the control sample of the present study may be attributed to the absence of the experimental ingredient, which likely improved the visual appearance of the formulated chips (Figure 2) (Charoen *et al*., 2015).

The flavour scores of the control and experimental samples were 7.15±0.81, 7.55±0.88, 8.25±0.71 and 7.7±0.80, respectively. Among all the samples, the highest taste score was observed in T2 (8.25±0.71) while the control sample T0 recorded the lowest score (7.15±0.81). The present findings are consistent with the results reported by Molla *et al*. (2008) who observed that P2 chips (7.70%) achieved higher taste scores compared to the control sample (5.60%), indicating improved sensory acceptability withy ingredient modification. The results indicate that the incorporation of experimental ingredients enhances the taste acceptability relative to the control (Figure 3) (Molla *et al*., 2008).

The Taste scores of the control and experimental chips were 7.45±0.68, 7.7±0.97, 8.25±0.55 and 8.05±0.68 respectively. Among all the samples, the highest taste score was observed in T2 (8.25±0.55) while the control sample T0 recorded the lowest score (7.45±0.68). The present findings are consistent with the results reported by Cheng *et al*. (2022), who observed that Formulation 1 chips (6.54%) achieved higher taste scores than the control sample (5.60%) indicating improved sensory acceptability with ingredient modification. The results indicate that the incorporation of experimental ingredients improved the taste acceptability compared to the control sample (Figure 4) (Cheng *et al*., 2022).

The texture scores of the control and experimental chips were 7.25±0.78, 7.65±0.81, 8.2±0.76 and 7.8±0.76 respectively. The highest texture score was observed in T2 sample (8.2±0.76) whereas the control sample T0 (7.25±0.78) recorded a lower score. These findings are in agreement with the study by Maha *et al*. (2019), who reported that texture of T4 chips (8.30%)

Table 1: Formulation of Control Experimental *Alternanthera sessilis* Chips.

Ingredients (g)	T0	T1	T2	T3
Wheat flour	70	65	60	55
Alternanthera sessilis leaves	0	5	10	15
Black gram flour	12	12	12	12
Pigeon pea flour	12	12	12	12
Chilli powder	2.0	2.0	2.0	2.0
Salt	1.0	1.0	1.0	1.0
Carrom seeds	1.0	1.0	1.0	1.0
Onion powder	1.0	1.0	1.0	1.0
Garlic powder	1.0	1.0	1.0	1.0

T0 - 70:0 (wheat flour, *Alternanthera sessilis* leaves), T1 - 65:5 (wheat flour: *Alternanthera sessilis* leaves), T2 - 60:10 (wheat flour: *Alternanthera sessilis* leaves), T3 - 55:15 (wheat flour: *Alternanthera sessilis* leaves).

Table 2: Sensory analysis of control and experimental chips.

Sensory Attributes	T0	T1	T2	T3
Appearance	6.85±0.74a	7.4±0.82be	7.8±0.61ce	7.75±0.63de
Colour	7.5±0.76a	7.7±0.86a	7.9±0.85a	7.65±0.67a
Flavour	7.15±0.81a	7.55±0.88ag	8.25±0.71bde	7.7±0.80cdfg
Taste	7.45±0.68a	7.7±0.97ad	8.25±0.55be	8.05±0.68cde
Texture	7.25±0.78a	7.65±0.81ad	8.2±0.76be	7.8±0.76cde
Overall Acceptability	6.65±0.87a	7.3±0.86be	8.2±0.89c	7.25±0.78de

Mean values followed by the different letters with subscript within the row are significantly different ($p<0.05$).

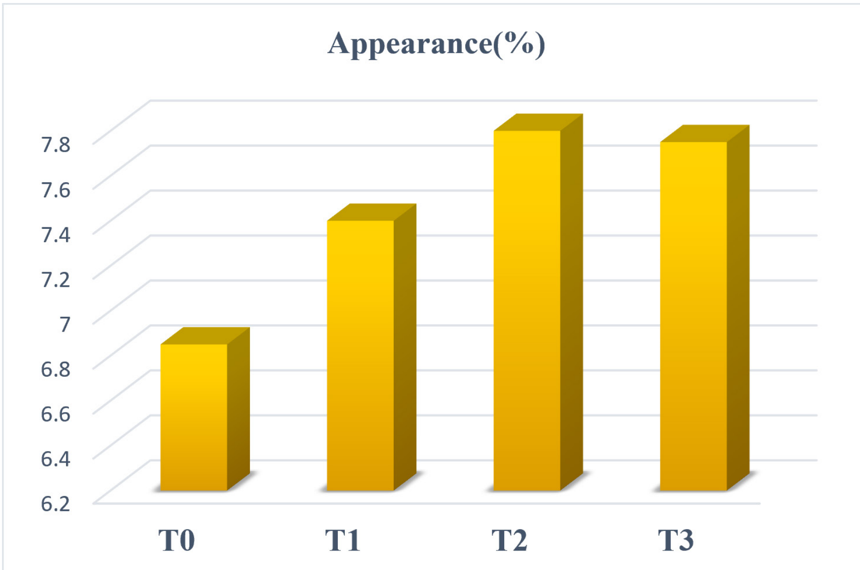

Figure 1: Appearance of control and experimental chips.

was higher compared to the control sample (8.10%). The lower texture observed in the control sample of the present study may be attributed to the absence of the experimental ingredient, which could have contributed to improved crispiness, structural integrity, and overall mouthfeel in the formulated chips (Figure 5) (Ali *et al.*, 2019).

The overall acceptability scores of the control and experimental chips were 6.65± 0.87, 7.3±0.86, 8.2±0.89 and 7.25±0.78 respectively. The highest overall acceptability was observed in T2 samples (8.2±0.89) whereas the control sample T0 recorded the lowest score (6.65±0.87). These findings are in agreement with the study by Harika *et al.* (2024), who reported that the formulation 1 of fried soyabean chips incorporated with moringa leaf powder (7.8%) showed higher overall acceptability compared to the control sample. The higher preference may be attributed to the optimal incorporation level of the experimental ingredient in T2, which enhanced taste, flavour, and overall palatability without producing any undesirable sensory characteristics (Figure 6) (Harika *et al.*, 2024).

Nutritional properties of control and experimental samples

Nutritional properties of control and experimental chips was reported in Table 3. The Protein content of T1, T2, T3 (9.34±0.13, 10.38±0.13, 11.07±0.13) is higher than that of control chips (8.69±0.08) (Figure 7).

The protein content of the control and experimental chips was 8.69±0.08, 9.34±0.13, 10.38±0.13, and 11.07±0.13, respectively. As shown in Table 2, the significant highest protein content was observed in the T3 sample (11.07%), whereas the lowest value was recorded in the control sample (T0) at 8.69%. These findings are in agreement with the study by Ranil Coorey *et al.* (2012), who reported that treatment 4 chips (7.14%) had a higher protein content compared to the control sample (3.87%). The lower protein content observed in the control sample of the present study may be attributed to the absence of *Alternanthera sessilis* leaves, which contributed to the increased protein levels in the experimental formulations (Coorey et al., 2012).

The fat content of the control and experimental chips was 3.44±0.09, 3.04±0.07, 2.67±0.10, and 2.45±0.07, respectively. Table 2 shows that the significant highest fat content was observed in the control sample (3.44%), while the lowest value

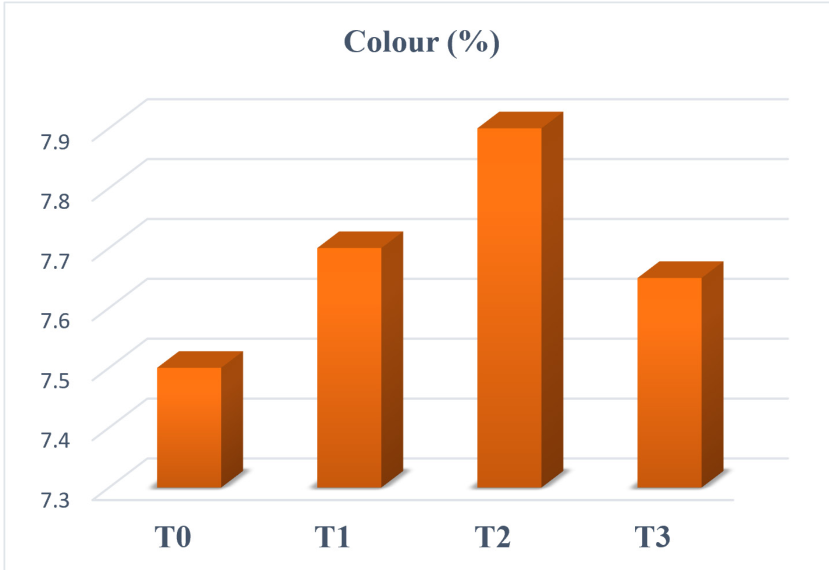

Figure 2: Colour of control and experimental chips.

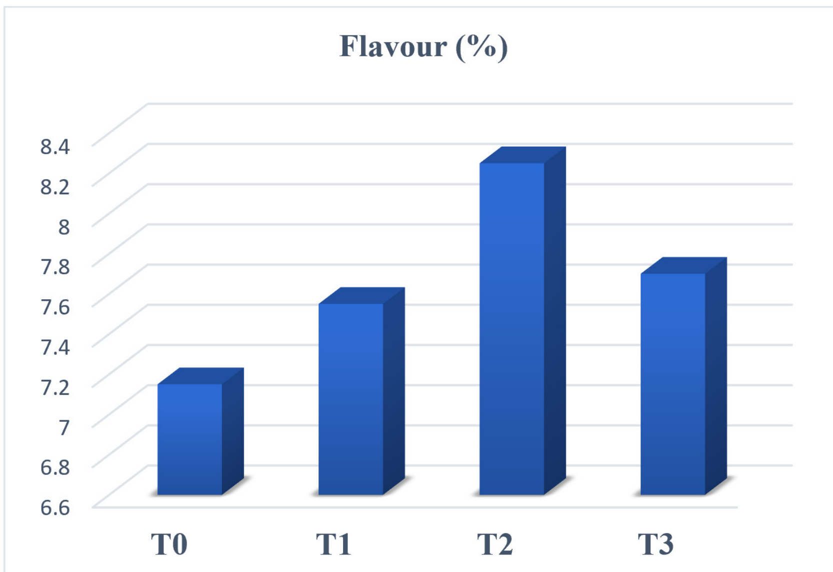

Figure 3: Flavour of control and experimental chips.

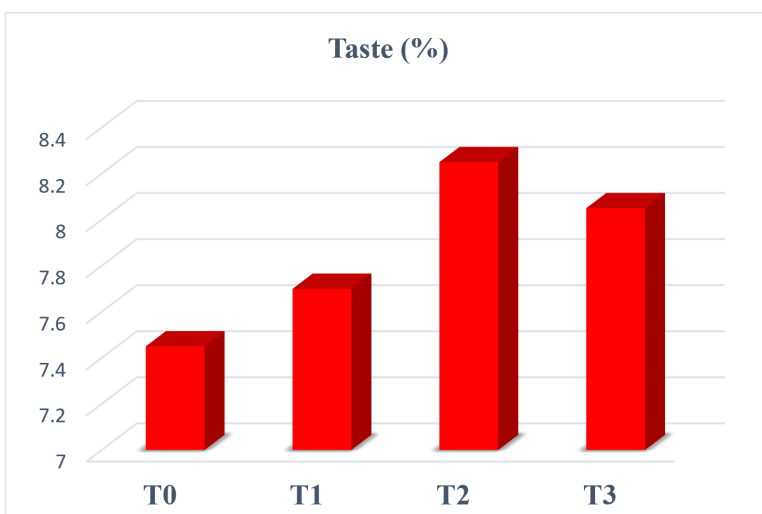

Figure 4: Taste of control and experimental chips.

was recorded in the T3 sample (2.45%). These findings are similar to those reported by Harika *et al.* (2024), who stated that the fat content of F0 (18±0.7) was higher than that of F3 (2.11±0.19). The higher fat content in the control sample of the present study may be due to the absence of *Alternanthera sessilis* leaf powder, whereas its incorporation in the experimental samples increased the fiber and solid content, thereby reducing the overall fat percentage (Harika et al., 2024).

The fibre content of the control and experimental chips was 4.18±0.10, 10.31±0.25, 12.31±0.27, and 13.77±0.14, respectively. As shown in Table 2, the significant highest total fibre content was observed in the T3 sample (13.77%), while the lowest value was recorded in the control sample (T0) at 4.18%. These findings are in agreement with Vázquez-Durán *et al.* (2014), who reported that the total fibre content of sample "D" chips (3.1±0.1) was higher than that of the control sample (1.9±0.1). The lower fibre content in the control sample of the present study may be attributed to the absence of *Alternanthera sessilis* leaves, whereas their incorporation in the experimental samples significantly increased the total fibre content (Vázquez-Durán et al., 2014).

The iron content of the control and experimental chips was 2.54±0.03, 3.04±0.03, 3.35±0.01, and 3.67±0.02, respectively. As presented in Table 2, the significant highest iron content was observed in the T3 sample (3.67%), while the lowest value was recorded in the control sample (T0) at 2.54%. These findings are consistent with the study by Sutrisno *et al.* (2024), who reported that the total iron content of P4 treatment (5.75±0.07) was higher than that of the control sample (3.28±0.03). The lower iron content in the control sample of the present study may be attributed to the absence of *Alternanthera sessilis* leaves, whereas their incorporation in the experimental formulations contributed to the increased iron content (Prayitno et al., 2024).

The ash content of the control and experimental chips was 3.23±0.08, 4.12±0.03, 3.57±0.30, and 5.08±0.02, respectively. The highest ash content was observed in the T3 sample (5.08%), while the lowest value was recorded in the control sample (T0) at

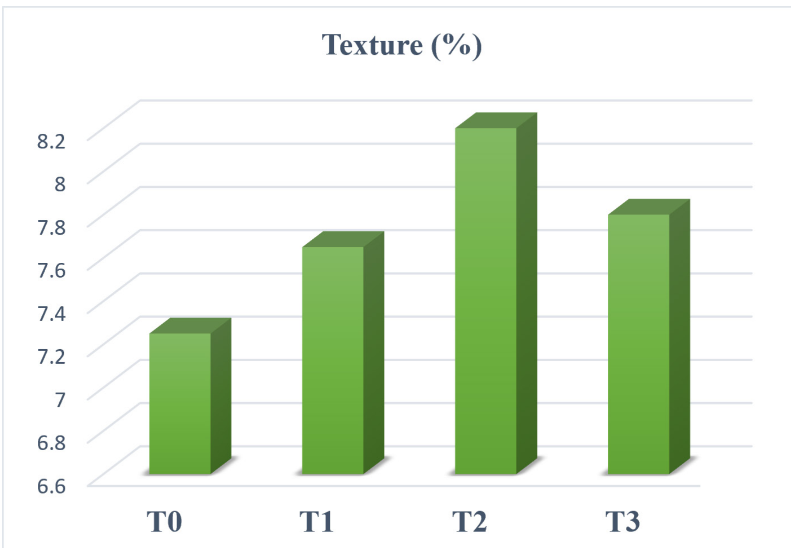

Figure 5: Texture of control and experimental chips.

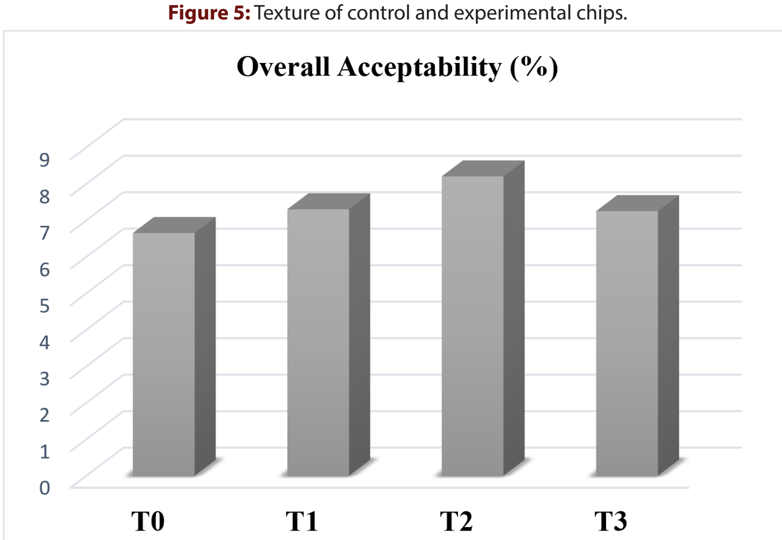

Figure 6: Overall Acceptability of control and experimental chips.

Table 3: Nutritional properties of control and experimental chips.

Nutritional properties	T0	T1	T2	T3
Protein (%)	8.69±0.08[a]	9.34±0.13[b]	10.38±0.13[c]	11.07±0.13[d]
Fat (%)	3.44±0.09 [a]	3.04±0.07 [b]	2.67±0.10 [c]	2.45±0.07 [d]
Iron (%)	2.54±0.03 [a]	3.04±0.03 [b]	3.35±0.01 [c]	3.67±0.02 [d]
Total dietary fiber (%)	4.18±0.10 [a]	10.31±0.25 [b]	12.31±0.27 [c]	13.77±0.14 [d]
Moisture (%)	5.62±0.20a	3.66±0.22b	2.60±0.29ce	2.17±0.17de
Ash (%)	3.23±0.08a	4.12±0.03b	3.57±0.30a	5.08±0.02c
Carbohydrate (%)	75.12±0.59a	69.51±0.54b	68.44±0.22c	65.71±0.12d
Energy (kcal)	366.24±2.50a	342.80±1.47be	341.58±1.20cef	332.53±4.54deg

Mean values followed by the different letters with subscript within the row are significantly different ($p<0.05$).

3.23%. However, the ash content of the T2 formulation (3.57%) was lower than that of the T1 formulation (4.12%), indicating slight variation among the treatments. These findings are in agreement with Cheng, Leong, and Chan (2022), who reported that the ash content of F2 chips (2.03±0.10) was higher than that of the control sample (1.35±0.10). The lower ash content in the control sample of the present study may be attributed to the absence of *Alternanthera sessilis* leaves, which are rich in minerals and contributed to the increased ash content in the experimental samples (Cheng et al., 2022).

The moisture content of the control and experimental chips was 5.62±0.20, 3.66±0.22, 2.60±0.29, and 2.17±0.17, respectively. As presented in Table 2, the highest moisture content was observed in the T0 sample (5.62%), while the lowest value was recorded in the T3 sample (2.17%). A similar trend was reported by Ratchanee *et al*. (2015), who found that the moisture content of the 80:10 treatment (3.05±0.47) was higher than that of the 120:20 treatment (2.45±1.93). The higher moisture content in the control sample of the present study may be attributed to the absence of *Alternanthera sessilis* leaf powder, whereas its incorporation in the experimental samples likely enhanced moisture reduction during air frying, resulting in lower moisture levels (Charoen et al., 2015)

The Carbohydrate content of the control and experimental chips was 75.12±0.59, 69.51±0.54, 68.44±0.22, and 65.71±0.12, respectively. As presented in Table 2, the highest carbohydrate content was observed in the T0 sample (75.12%), while the lowest value was recorded in the T3 sample (65.71%). A similar trend was reported by Haifa Benkhoud, Yassine Mrabet , Nadia Nasraoui, Wided Bellazreg, Faten Daly, Najet Chaabane and Karim Hosni who found that the carbohydrate content of the control sample (65.65±4.12) was higher than that of sample 6 (61.89±3.67). The higher carbohydrate content in the control sample of the present study may be attributed to the higher proportion of wheat flour, whereas the decrease in carbohydrate content in the experimental samples could be attributed to the reduction in wheat flour and the increase in other ingredients such as *Alternanthera sessilis* leaf powder and pulse flours, resulting in lower carbohydrate levels (Benkhoud et al., 2022) (Table 3).

The Energy content of the control and experimental chips was 366.24±2.50, 342.80±1.47, 341.58±1.20, and 332.53±4.54, respectively. As presented in Table 2, the highest energy content was observed in the T0 sample (366.24%), while the lowest value was recorded in the T3 sample (332.53%). A similar trend was reported by Maha *et al*. (2019) who found that the energy content of the control sample (342.09±6.41) was higher than that of T6 (319.52±0.74). The energy content in the control sample of the present study may be attributed to the higher proportion of wheat flour and overall carbohydrate content, which contributes significantly to total caloric value. In the experimental samples, the partial replacement of wheat flour with *Alternanthera sessilis* leaf powder and pulse flours slightly reduced the carbohydrate and fat proportions, resulting in lower energy levels (Ali et al., 2019).

Effect of Storage period on sensory analysis of selected chips

Effect of storage period on sensory analysis of control and experimental chips was presented in Table 4. Hedonic scores for all sensory attributes showed a significant decrease as the storage period increased.

Hedonic scores for all sensory attributes showed a significant decrease during the storage period. The appearance scores of the selected chips during the 0^{th}, 15^{th} and 30^{th} day of storage were 7.8±0.61, 7.6±0.75 and 6.8±0.76 respectively. As presented in the sensory evaluation table, the highest appearance score was observed on the 0^{th} day, while the lowest value was recorded on the 30^{th} day. A similar declining trend in appearance during storage was reported by Surbhi Shekhawat, Vimla Dunkawal and Mamta Singh (2023) in low GI salty biscuits. The gradual decrease in appearance scores during storage may be attributed to moisture absorption, slight colour deterioration and loss of surface crispness which could have negatively affected the visual quality and consumer acceptability of the chips over time (Shekhawat et al., 2023).

Hedonic scores for all sensory attributes showed a significant decrease during the storage period. The colour scores of the selected chips during the 0th, 15th and 30th day of storage were 7.9±0.85, 7.75±0.78 and 6.7±0.57 respectively. The highest colour score was observed on the 0th day, while the lowest value was recorded on the 30th day. A similar declining trend in colour during storage was reported by Ahmad *et al.* (2003) in stored snack products. The gradual decrease in colour scores during storage may be attributed to moisture absorption, oxidation reactions and non-enzymatic browning, which could have adversely affected the visual appearance and overall acceptability of the chips over time (Figure 8) (Sulaeman et al., 2003).

Hedonic scores for all sensory attributes showed a significant decrease during the storage period. The taste scores of the selected chips on 0th, 15th and 30th day of storage were 8.25±0.55, 7.85±0.74 and 6.65±0.87 respectively. The highest taste score was observed on the 0th day, while the lowest value was recorded on the 30th day. A similar declining trend in sensory quality during storage was reported by *Shafia et al.* (2004) in wheat bran-enriched tortilla chips. The gradual decrease in taste scores during storage may be attributed to moisture absorption, lipid oxidation and loss of freshness, which could have negatively affected the taste and overall palatability of the product over time (Figure 9) (Ashraf et al., 2024).

Hedonic scores for all sensory attributes showed a significant decrease during the storage period. The texture scores of the selected chips during the 0th, 15th and 30th day of storage were 8.2±0.76, 7.65±0.81 and 6.6±0.50 respectively. The highest texture score was observed on the 0th day, while the lowest value was recorded on the 30th day. A similar declining trend in texture scores during storage period was reported by Imran *et al.* (2002), who observed a gradual decrease in the texture scores of cookies during storage. The reduction in texture scores in the present study may be attributed to moisture absorption and loss of crispness during storage, which could have adversely affected the texture and overall sensory quality of the chips (Figure 10) (Pasha *et al.*, 2002).

Hedonic scores for all sensory attributes showed a significant decrease during the storage period. The flavour scores of the selected chips during the 0th, 15th and 30th day of storage were 8.25±0.71, 7.7±0.86 and 6.55±0.60 respectively. The highest flavour score was observed on the 0th day, while the lowest value was recorded on the 30th day. A similar declining trend in flavour during storage was reported by Upasana *et al.* (2018) in nutritionally enriched extruded snacks. The gradual decrease in flavour scores during storage may be attributed to moisture absorption, lipid oxidation, and overall sensory quality of chips over time (Figure 11) (Yadav *et al.*, 2018).

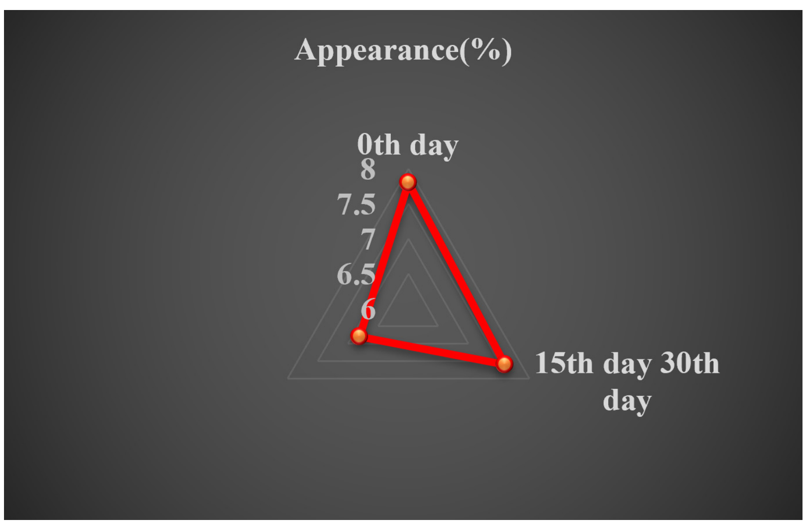

Figure 7: Appearance of selected *Alternanthera sessilis* chips.

Table 4: Effect of Storage period on sensory analysis of selected chips.

Sensory Attributes	0th day	15th day	30th day
Appearance	7.8±0.61a	7.6±0.75a	6.8±0.76b
Colour	7.9±0.85a	7.75±0.78a	6.7±0.57b
Taste	8.25±0.55a	7.85±0.74a	6.65±0.87b
texture	8.2±0.76a	7.65±0.81b	6.6±0.50c
Flavor	8.25±0.71a	7.7±0.86b	6.55±0.60c
Overall Acceptability	8.20±0.89a	7.95±0.39a	6.65±0.58b

Mean values followed by the different letters with subscript within the row are significantly different (p<0.05).

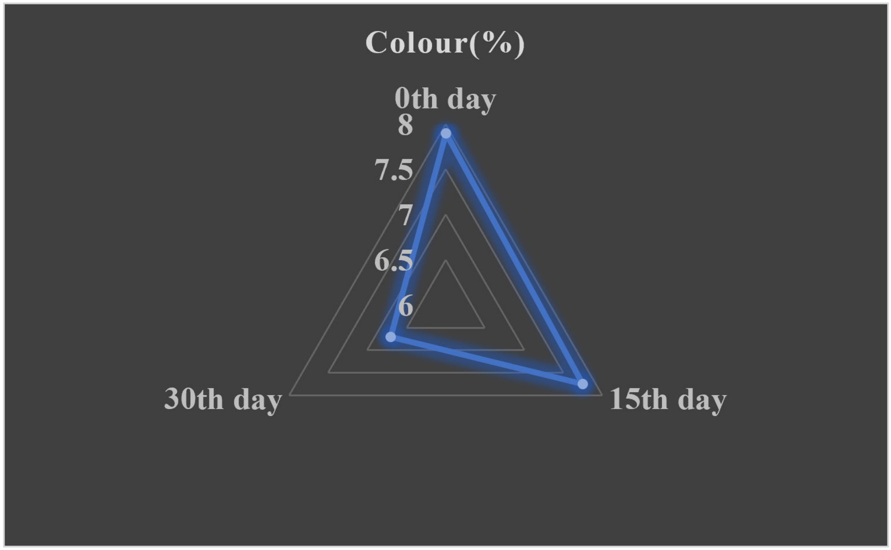

Figure 8: Colour of selected *Alternanthera sessilis* chips.

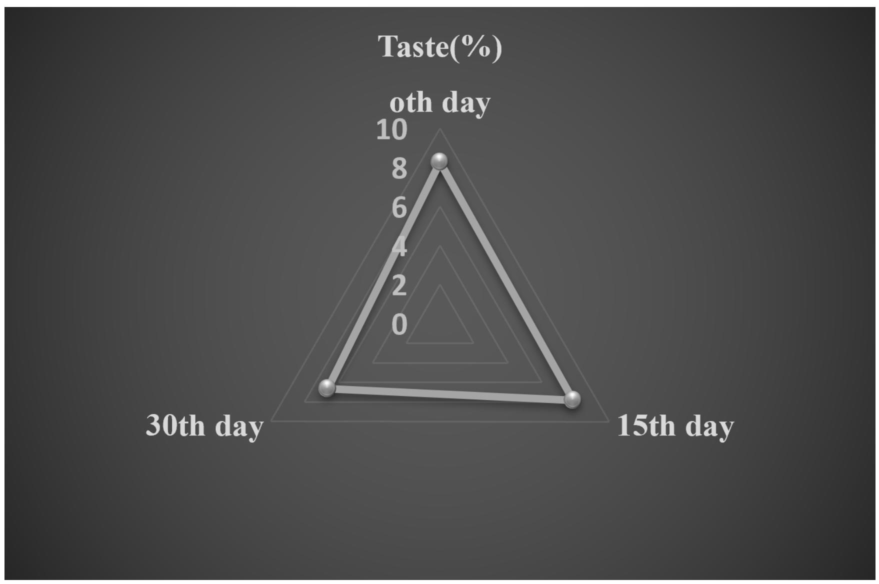

Figure 9: Taste of selected *Alternanthera sessilis* chips.

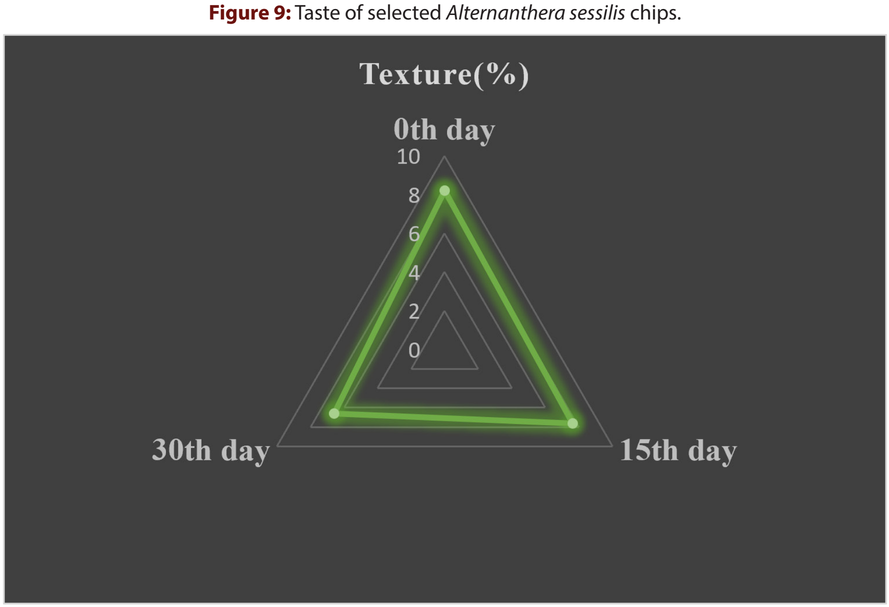

Figure 10: Texture of selected *Alternanthera sessilis* chips.

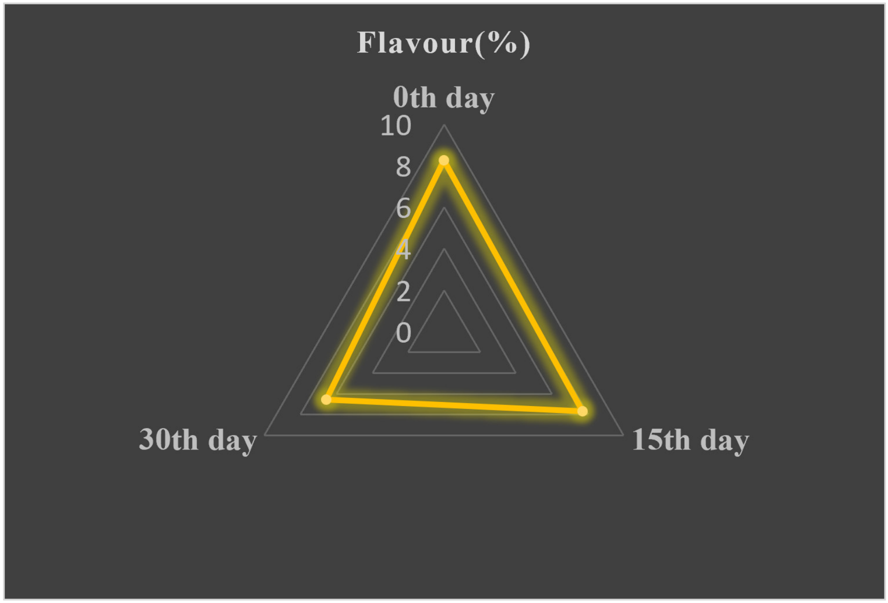

Figure 11: Flavour of selected *Alternanthera sessilis* chips.

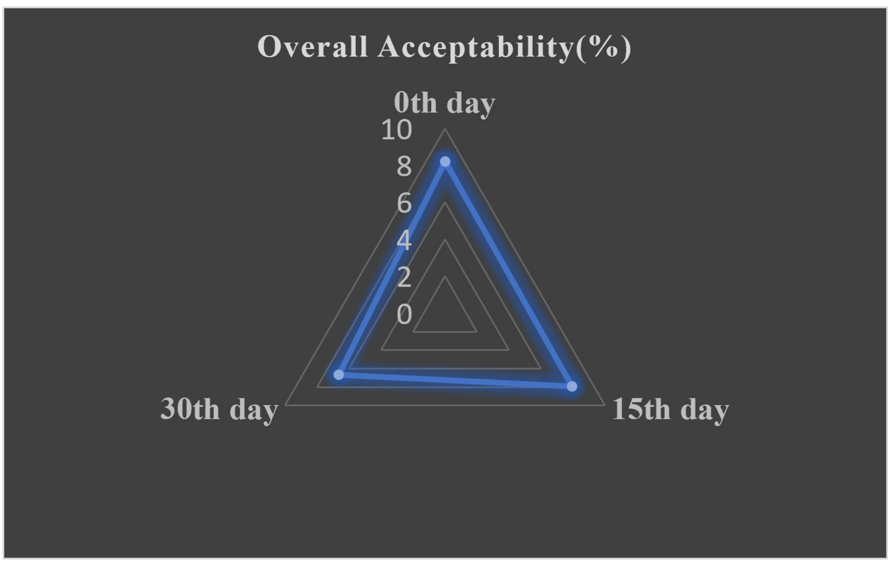

Figure 12: Overall Acceptability of selected *Alternanthera sessilis* chips.

Hedonic scores for all sensory attributes showed a significant decrease during the storage period. The overall acceptability scores of the selected chips during the 0^{th}, 15^{th} and 30^{th} day of storage were 8.20±0.89, 7.95±0.39 and 6.65±0.58 respectively. The highest overall acceptability score was observed on the 0^{th} day, while the lowest value was recorded on the 30^{th} day. A similar declining trend in overall acceptability during storage was reported by Surbhi *et al.* (2023) in low GI salty biscuits. The gradual decrease in overall acceptability during storage may be attributed to changes in appearance, flavour, texture and taste caused by moisture absorption and oxidation reactions, which could have negatively affected the sensory quality (Figure 12) (Shekhawat et al., 2023).

CONCLUSION

The results revealed that the incorporation of *Alternanthera sessilis* leaf powder significantly improved both the sensory and nutritional characteristics of the chips compared to the control sample. Among the different formulations, T2 exhibited the highest sensory acceptability. These results demonstrate that supplementation with *Alternanthera sessilis* leaf powder significantly improved the nutritional profile of the chips by enriching protein, fibre, iron, and mineral contents while reducing fat, carbohydrates, moisture, and caloric value. The storage study indicated a gradual decline in sensory attributes throughout the storage period. Nevertheless, the chips remained organoleptically acceptable throughout the entire storage period. *Alternanthera sessilis* leaf powder can be effectively utilized as a functional ingredient in the development of air-fried chips. While

T2 achieved the highest sensory acceptability, T3 demonstrated superior nutritional quality. Therefore, the incorporation of *Alternanthera sessilis* leaf powder not only enhanced consumer acceptance but also improved the nutritional value of the product, highlighting its potential as a value-added functional snack with satisfactory storage stability.

ACKNOWLEDGEMENT

The authors acknowledge the Course of Department of Clinical Nutrition and Dietetics, School of Allied and Healthcare Sciences, Malla Reddy University, Hyderabad for providing the required laboratory facilities in carrying out the study.

ETHICAL STATEMENT

The sensory evaluation adhered to institutional guidelines, and all participants provided written informed consent prior to their participation.

ABBREVIATIONS

ANOVA: Analysis of Variance; **ASG:** *Alternanthera sessilis* Green Variety; **ASR:** *Alternanthera sessilis* Red Variety; **CND:** Clinical Nutrition and Dietetics; **LFNMR:** Low-field nuclear magnetic resonance; **LSD:** Least significant difference; **SPSS:** Statistical Package for the Social Sciences.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: KJ and DPK; Experiments: PJJ; Data analysis: KJ, PJJ, DPK, NV and KG; Supervision: KJ; Funding: PJJ, NV and KG; Manuscript writing: PJJ, KJ and DPK

SUMMARY

- Alternanthera sessilis leaf powder was incorporated into chips to develop a nutrient-enriched functional snack.
- The sensory evaluation showed that T2 formulation was the most preferred with overall acceptability score of 8.20 ± 0.89.
- T2 recorded higher sensory scores for appearance (7.80 ± 0.61), color (7.90 ± 0.85), flavor (8.25 ± 0.71), taste (8.25 ± 0.55), and texture (8.20 ± 0.76).
- Incorporation of Alternanthera sessilis leaf powder increased protein content from 8.69% to 11.07%, fiber from 4.18% to 13.77%, iron from 2.54% to 3.67%, and ash from 3.23% to 5.08%.
- The addition of leaf powder reduced fat content (3.44% to 2.45%), moisture (5.62% to 2.17%), carbohydrate (75.12% to 65.71%), and energy value (366.24 to 332.53 kcal/100 g).
- Storage studies for 30 days showed a gradual decline in sensory quality due to moisture absorption and loss of crispness.

REFERENCES

Ali, I. K., & M. (2019). Production of Healthy Chips Ready to Eat Using Potato, Green Pea and Lupine Flour for Malnourished Children. International Journal of Food Science and Biotechnology, 4(1), 26-34. https://doi.org/10.11648/j.ijfsb.20190401.14

Alwis, H. D., G., Wijesekera, R., & Jayasekera, T. (2006). Use Patterns and Residue Levels of Pesticides on Mukunuwenna, a Leafy Vegetable Grown in Sri Lanka. Bulletin of Environmental Contamination and Toxicology, 76(1), 119-125. https://doi.org/10.1007/s00128-005-0897-3

Anju, T., Parvathy, S., Veettil, V., M., Rosemary, J., Ansalna, T., Shahzabanu, M., & Devika, S. (2021). Green synthesis of silver nanoparticles from *Aloe vera* leaf extract and its antimicrobial activity. Materials Today: Proceedings, 43(5), 3956-3960. https://doi.org/10.1016/j.matpr.2021.02.665

Ashraf, S., Sood, M., & Bandral, J. (2024). Shelf Stability of Tortilla Chips Enriched with Microwave Stabilized Wheat Bran. European Journal of Nutrition & Food Safety, 16(12), 55-66. https://doi.org/10.9734/ejnfs/2024/v16i121602

B, A., & K, M. (2014). Anatomical studies on the seeds of *Alternanthera sessilis* Linn. International Journal of Research in Ayurveda & Pharmacy, 1(1), 9-15. https://doi.org/10.7897/2277-4343.05368

Benkhoud, H., Mrabet, Y., Nasraoui, N., Bellazreg, W., Daly, F., Chaabane, N., & Hosni, K. (2022). Chemical compositions, fatty acid profiles and selected contaminants in commercial potato and corn chips sold in the Tunisian market. Discover Food, 2(1), 30. https://doi.org/10.1007/s44187-022-00030-8

Bormann, M., & Liebig, H. (2002). Ultrasonic acoustic emission of broccoli (*Brassica oleracea* L. convar. botrytis var. italica Plenck) to indicate water stress. Acta Horticulturae, 53(4), 313-323. https://doi.org/10.17660/actahortic.2002.593.2

Ch., H., G, S., A, N., & G, R. (2024). Development of soybean chips incorporated with moringa leaf powder and tomato powder. International Journal of Advanced Biochemistry Research, 8(5), 293-302. https://doi.org/10.33545/26174693.2024.v8.i5sd.1265

Charoen, R., Lakerd, S., & J., K. C. D. O. S. G. O. M. C. U. V. F. P. F. A. B. (2015).;3(2):100-108.

Cheng, K., Leong, K., & Chan, S. (2022). Cricket as an alternative source of protein in the development of nutritious baked chips. Food Research, 6(2), 74-82. https://doi.org/10.26656/fr.2017.6(s2).018

Chitrakar, B., Zhang, M., Zhang, X., & Bhandari, B. (2022). Valorization of asparagus-leaf by-product through nutritionally enriched chips to evaluate the effect of powder particle size on functional properties and rutin contents. Drying Technology, 41(1), 34-45. https://doi.org/10.1080/07373937.2022.2080703

Coorey, R., Grant, A., & Jayasena, V. (2012). Effects of Chia Flour Incorporation on the Nutritive Quality and Consumer Acceptance of Chips. Journal of Food Research, 1(4), 85-95. https://doi.org/10.5539/jfr.v1n4p85

Huong, N., & Truong, D. (2025). The Physical Properties, Structure, and Sensory Characteristics of Cookies Replacing Lotus Seed Flour and Low Glycemic Index Sugar. … Journal of Natural Product …, 4(2), 245-248. https://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=26160684&AN=185883624&h=QUKojc%2Bv%2Fbi%2BQmxzm5VrPFL3cBoydIbEL9LEhaJ6MmcIcAQoJany6ev%2BRUAWxgwL%2Bfcpf33oPhCdolDtWSneIw%3D%3D&crl=c

Lin, S., Lin, Y., Shyuu, S., & Lin, C. (1994). Hepatoprotective effects of Taiwan folk medicine: *Alternanthera sessilis* on liver damage induced by various hepatotoxins. Phytotherapy Research, 8(7), 391-398. https://doi.org/10.1002/ptr.2650080703

Liu, L., Winter, K., Stevenson, L., Morris, C., & Leach, D. (2012). Wheat bran lipophilic compounds with *in vitro* anticancer effects. Food Chemistry, 130(1), 156-164. https://doi.org/10.1016/j.foodchem.2011.07.023

Molla, M., Islam, M., Nasrin, T., & Bhuyan, M. (1970). Survey on postharvest practices and losses of litchi in selected areas of Banglades. Bangladesh Journal of Agricultural Research, 3(6), 41-47. https://doi.org/10.3329/bjar.v35i3.6451

Prayitno, S., Ningrum, S., & Putri, S. (2024). Enhancing nutritional value: Iron -rich chips with moringa, mocaf and milkfish for anemia prevention. Agroindustrial Technology Journal, 8(2), 1-16. https://doi.org/10.21111/atj.v8i2.12555

Quayson, E., Atwell, W., Morris, C., & Marti, A. (2016). Empirical rheology and pasting properties of soft-textured durum wheat (*Triticum turgidum* ssp. durum) and hard-textured common wheat (*T. aestivum*). Journal of Cereal Science, 69(2), 252-258. https://doi.org/10.1016/j.jcs.2016.03.017

Rajapakse, R., & Beneragama, C. (2016). The Effect of 1-Methylcyclopropene on Postharvest Life of Sessile Joyweed (*Alternanthera sessilis*). Procedia Food Science, 6(1), 283-287. https://doi.org/10.1016/j.profoo.2016.02.056

RP, M., RB, K., BS, A., BM, P., & SD, K. (2023). Effects of germination on antinutritional, colour, functional and physicochemical properties of millets. The Pharma Innovation, 11(3), 229-234. https://doi.org/10.22271/tpi.2023.v12.i1d.18008

Shang, J., Li, L., Zhao, B., Liu, M., & Zheng, X. (2020). Comparative studies on physicochemical properties of total, A- and B-type starch from soft and hard wheat varieties. International Journal of Biological Macromolecules, 154(1), 714-723. https://doi.org/10.1016/j.ijbiomac.2020.03.150

Sharma, S., Katyal, M., Singh, N., Singh, A., & Ahlawat, A. (2021). Comparison of effect of using hard and soft wheat on the high molecular weight-glutenin subunits profile and the quality of produced cookie. Journal of Food Science and Technology, 59(7), 2545-2561. https://doi.org/10.1007/s13197-021-05272-5

Shekhawat, S., Dunkwal, V., evaluation, S. M. Q., & J., P. O. L. G. S. B. F. T. D. P. I. (2023).;12(12):2515-2516.

Shewry, P. (2022). Wheat grain proteins: Past, present, and future. Cereal Chemistry, 100(1), 9-22. https://doi.org/10.1002/cche.10585

Subhashini, N., Krishnaveni, B., & Res., S. R. P. A. A. O. A. S. L. R. E. D. I. J. P. S. (2010). *Alternanthera sessilis* (Linn.) R. Br. ex DC. SpringerReference, 1(10), 199-204. https://doi.org/10.1007/springerreference_68031

Sulaeman, A., Keeler, L., Giraud, D., Taylor, S., & Driskell, J. (2003). Changes in carotenoid, physicochemical and sensory values of deep-fried carrot chips during storage. International Journal of Food Science and Technology, 38(5), 603-613. https://doi.org/10.1046/j.1365-2621.2003.00689.x

Sunmathi, D., Sivakumar, R., anti-inflammatory, R. K. I. V., antiarthritic activity of ethanolic leaf extract of *Alternanthera sessilis* (L.) R.Br. ex, D. C., & Chem., A. P. M. G. I. J. A. P. B. (2016). *Alternanthera sessilis* (Linn.) R. Br. ex DC. SpringerReference, 5(1), 109-115. https://doi.org/10.1007/springerreference_68031

Yadav, U., Singh, R., & Arora, S. (2018). Evaluation of quality changes in nutritionally enriched extruded snacks during storage. Journal of Food Science and Technology, 55(10), 3939-3948. https://doi.org/10.1007/s13197-018-3319-3

Cite this article: Jyothsna PJ, Jagannadham K, Vaishnavi N, Gayathri K, Kumari DP. Preparation, Sensory and Nutritional Evaluation of *Alternanthera sessilis* Chips. Asian J Biol Life Sci. 2026;15(2):518-29.